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Vol. XVI No. 12


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# Something to Come Home to

**If you could** grant wishes like Cinderella's fairy godmother—so someone recently said—here are requests you'd get from the armed forces. No. 1: "Please, I'd like to go fishing." No. 2: "Please let me go hunting." No. 3: "Be real swell and fix it up for me to spend three months in the mountains."

That's easy to believe. Few things are so different as life in a fox-hole and life along a trout stream. It's a world of no enemies when you're out among the shreds of dawn, with molten ice tugging your ankles—and a ten-inch rainbow at the end of your line.

One reason good hunting and fishing—indeed, a whole good outdoors—awaits every returning western warrior can be found in the many rod and gun clubs. For men who love air swept clean by treetops and laundered in glacier water, these clubs have been guardians of the future.

They've fulfilled a volunteer stewardship with constant efforts to improve every stamping-ground of the sportsman. Their interest has helped break new trails everywhere into the outdoors—and to widen old ones. Progressive fish and game commissions have found them aiding every advanced program.

Whether man or woman, every westerner has something of the woodsman's heritage. Whether it's skiing or shooting or just loafing under the clear stars, every westerner loves some form of outdoor life. For everyone of them, the rod and gun clubs have guarded the land where mornings are born and the heart sings.

**STANDARD OF CALIFORNIA**

E flag with 4 stars,
awarded to our Richmond Refinery

# The Course of Oil

by K. C. SCLATER

## ESTIMATING GAS RESERVES

In estimating future potential reserves of natural gas, it is doubtful that the yield of gas from condensate fields of the future has been given the weight it merits. E. DeGolyer, in discussing the nation's reserves of natural gas before the Interstate Oil Compact Commission recently at Oklahoma City, pointed out that: "It is common knowledge that deeper drilling has resulted in finding the natural hydrocarbons increasingly in the gaseous phase and it is only reasonable to expect that this trend will continue and that, with increasing depth, the proportion of gas discovered to that of oil will be increasingly greater. Further, as more wells are carried to greater depths, higher reservoir pressures will be encountered. If only oil is present within these pools, it is likely to be charged with gas to a greater degree per unit volume than the oil contained in shallower reservoirs. If only gas is present, it also will be under higher pressure and the porous strata, per unit volume, at least, will contain more gas."

On the reasonable assumption, then, that many of the prolific fields to be discovered in the future will be 10,000 ft. or more in depth and will likely be of the condensate type, future potential natural gas reserves may far exceed conservative estimates based on our limited experience to date with fields of this type. As a future potential reserve of natural gas, condensate fields should be given greater weight and emphasis.

## FACTORS FOSTERING CONSERVATION

Because of its importance as a commodity in interstate commerce, natural gas is, and will continue to be, under the close scrutiny of the Federal Power Commission. In this connection, several hearings on natural gas scheduled by the Commission in different parts of the country, will soon be under way. Potential reserves of natural gas in the United States will come in for some important discussion at these hearings.

Besides its present uses, natural gas has a promising future as an industrial raw material for the manufacture of many products and this has focused attention on its conservation and utilization, especially among state officials charged with the regulation of oil and gas production in their respective states. Having become keenly conscious of its value, state officials are beginning to show concern over waste of this irreplaceable and increasingly valuable natural resource.

Conservation of natural gas has always been impeded by lack of markets. Gas in large volume is produced with crude oil, and unless a ready market is available the oil producer is compelled to return the gas to the reservoir or blow it to the atmosphere. Were immediate markets always available for such gas its conservation would not be a problem. Oil producers would be encouraged to conserve every cubic foot of gas because of the extra revenue it would bring.

Pipe lines have been instrumental in creating a market for natural gas and so have enhanced its value. Because of this, they have probably been the most important factor to date in fostering the conservation and utilization of natural gas.

The trend toward greater conservation and fuller utilization of natural gas, and the elimination of its flagrant waste, is unmistakable. This is as it should be. To be noted and not forgotten in this connection is the part that availability of markets for natural gas can play in its conservation.

## PROFITABLE WATER-FLOODING

Progress in secondary recovery practices is recorded by C. F. Terrell, in a paper just released by the American Petroleum Institute.

An experimental water-flooding project under way since 1937 has led to improved methods of spacing and completing injection wells. Water flooding the 3000-ft. Berea sand in the Cabin Creek field, West Virginia, presented problems not confronted in fields of shallower depths. As old producers were first used as injection wells, the spacing of about 650 ft. between input well and producing well was fixed. Salt water was used for injection and came from a sand at a depth of 1200 ft. To prevent precipitation of solids the water system used was made gas- and air-tight and, except for filtration, no water treatment was necessary. Good results from water flooding were obtained.

Recently fresh creek water has been put into use. Treating equipment has been installed for vacuum deaeration, alum coagulation, and chlorination of the water, which is now completely stable and noncorrosive. In addition, greater latitude in spacing and better control of the water flood has resulted.

This is an example of what is being done to increase oil recovery and improve existing methods even in old fields.

# FOLLOW THE LEADERS TO *Silverlink*

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It's sound reason that so much Link-Belt Silverlink Finished Steel Roller Chain is used on internal combustion engine powered drilling rigs. Many operators have standardized on Silverlink on all rigs of this type because Silverlink has kept them out of chain trouble on their toughest jobs. Silverlink is the result of 70 years of continuous chain research and improvements for your safety, efficiency and economy. Demand Silverlink. It is available at most supply stores.

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*In cooperation with the government conservation program, Silverlink roller chain is now furnished in a durable "blackout" finish.

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LINK-BELT *Silverlink* ROLLER CHAINS

# *Scanning* WASHINGTON'S OIL HORIZON

MILBURN PETTY

WASHINGTON—The war's abrupt end caught the Government—but not the industry—with no program for disposing of the Big Inch and Little Big Inch pipe lines, 100-octane plants, and other government-owned fuel facilities.

Since last May an industry committee headed by W. Alton Jones, Cities Service president, has been studying the problem and preparing recommendations for the Senate Oil Committee, of which Senator O'Mahoney, Wyoming, is chairman.

Government agencies directly responsible for surplus disposal, including the Surplus Property Board, have been marking time to see what comes out at the O'Mahoney Committee hearings.

Senator O'Mahoney wants the hearings to be a roundtable discussion of all angles, with all viewpoints represented. For example, some independent refiners disagree with views on 100-octane plant disposal held by a majority of the industry subcommittee working on this. Senator O'Mahoney has promised them time for rebuttal.

Majority of the plant disposal committee, headed by Hines Baker (Humble Oil and Refining), believed the government should follow these policies in disposing of its 100-octane facilities: Plants should not be undervalued; they should be sold, not leased; terms should include 25 per cent cash down payment and a 5-year payout, with no government financial aid.

There has been considerable difference of opinion on what should be done with Big Inch and Little Big Inch. But opinion among the pipe line disposal committee, of which B. I. Graves (Tide Water Associated) is chairman, is reported crystallizing on these four points: (1) These big pipe lines should not be scrapped; (2) they should not be used for transporting crude oil or products; (3) their use for natural gas is feasible; and (4) if not used for natural gas, these two lines should be set aside for military use in event of another national emergency.

As to the other four War Emergency pipe lines, the industry committee favors this disposition for each: Southwestern, sell it to the highest bidder; Plantation's Greensboro-Richmond extension, sell it for re-use elsewhere; Trans-Florida, sell it for salvage, and Ohio Emergency, either sell it or dismantle for salvage.

RFC has retained Ford, Bacon & Davis, New York engineering firm, to make an appraisal of the Big Inch and Little Inch lines.

Surplus Property Board plans to set up a petroleum advisory committee, "to be drawn from leading members of the industry." Presumably, this group will be to advise SPB on the disposal of oil facilities and surplus products.

Department of Justice is taking very seriously its role in surplus property disposal. The law requires that the D. J. pass on the sale of all government-owned facilities valued at more than a million dollars. To prepare itself for reports on the "monopoly" angle, the D. J. plans to send out questionnaires to some 20 or 30 larger oil companies asking details of their holdings in the refining and transportation branches. (The Budget Bureau has approved the form of this questionnaire.) Data obtained probably will be used also in the D. J. reports on wartime concentration of economic power, required under Section 205 of the War Manpower & Reconversion Act of 1944.

● **CONTRACT TERMINATION.** PAW was so busy oiling the war right up to the Jap surrender, it had no time to plan adequately for the inevitable 100-octane cutback. The day that the Japs radioed their peace offer, PAW and RFC officials really got down to business on contract termination, especially as regards the DPC-owned plants. For these refineries, some kind of interim rental plan was needed so they could keep on operating until appraisals could be made and disposal negotiations concluded. PAW's hopes were that the war-oil machine could be slowed gradually, especially for refiners who would be hit hardest by cutbacks.

● **CRUDE OIL.** Peacetime finds the production branch with much more capacity than pre-war—but the overproduction may not be as much as the pessimists have feared. Elimination of government-subsidized crude movements will bring cutbacks in some fields. Subsidized imports also accounted for a considerable volume of East Coast refinery runs; for example, 75,000 bbl. per day from Venezuela. There will be a clamor from Capitol Hill to shut in Elk Hills Naval Petroleum Reserve, which was opened up to 65,000 bbl. per day during the latter months of the war. Also, PAW will be in no hurry to junk its production control program in California.

New civilian demand for gasoline and fuel oil, which may amount to 300,000 bbl. per day or more, will help fill the gap caused by military cutbacks. With a coal shortage impending, PAW figures heavy fuel oil can supply the equivalent of 12 to 14 million tons of coal, about 150,000 bbl. per day. Difference between rationing and unrestricted consumption of gasoline is expected to be at least 150,000 bbl. per day, nationally. Besides this new demand, authorities here expect that American refiners will also be called on to supply a considerable part of the unsatisfied requirements of Europe and South America.

End of the war raises a number of questions bearing on crude supply and prices. Shall congressional action be sought to make the stripper well subsidy a permanent policy? What are the prospects for import limitation? Tariff? These and other angles will be covered in testimony before the O'Mahoney Committee when it takes up its agenda topic, The Independent Company.

Independent producer representatives here are wondering if some of the larger oil companies, which have been bewailing—in their stockholders reports—the fact that OPA was holding crude prices down to levels below replacement costs, will take the lead in advancing crude as soon as government price control is lifted. (OPA wants to continue controlling oil prices until satisfied that the supply is sufficiently adequate to hold consumer prices down, prevent inflation.)

● **TIDELANDS.** Storm clouds are gathering in the Senate on the tidelands issue. Opposition (Senator Wheeler, Montana, for one) is developing to the quitclaim resolution giving title to submerged lands to the states. This measure has already passed the House. Senator McCarran, Nevada, chairman on the Senate Judiciary Committee, plans to hold hearings when Congress reconvenes in the fall.

Meanwhile, Florida Attorney General Watson has teamed up with Interior Secretary Ickes to ask that U. S. Attorney General Clark file an original suit in the U. S. Supreme Court against Florida to test the federal vs. state ownership claims to offshore submerged lands.

● **GOVERNMENT ROYALTY OIL.** Bids for the sale of government royalty oil under Interior Department's Order 2058, giving preference to independent refiner bidders, will be opened here August 24. Small refiners have advised Interior they would like crude from five Wyoming fields—Lance Creek, East Lance Creek, Little Buck Creek, Cole Creek and Salt Creek—and from three Colorado fields, Wilson Creek, Iles and Rangely. These are the fields on which bids will be submitted.

● **POSTSCRIPTS.** PAW's worldwide supply program includes 15,000 bbl. per day of crude oil from German wells to supply local needs . . . Eugene J. Houdry and other officers of the Houdry Process Corporation are en route to Moscow . . . Senator O'Mahoney, Wyoming, will hold hearings in the West on his bill (S. 1236) to change the oil and gas leasing law, sometime in August or September.

# LET *Fluid Power* DO THE TRACK WORK

No longer is it necessary for a pumper to spend his time pacing his lease. With the Kobe system of *fluid power*, it is possible for one man from a single, convenient location to control the pumping operations of a large number of wells. Although they may be miles away and 10,000 feet down, all operating information is continually available on the gauges at the central control plant. By simple valve regulation, all pumping operations are instantly responsive to any desired change of production volume.

The use of the hydraulic principle makes the Kobe system highly efficient. Power is effectively applied at the point of action: at the bottom of the well. The flexible nature of fluid power makes it readily adaptable to varying types of production.

If you would like to know more about the Kobe system of hydraulic pumping, ask for the booklet, "Modern Oil Well Pumping with Fluid Power." Any Kobe field representative will be glad to give you a copy. Or write to the nearest address below.

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**PUMP THE MODERN WAY—USE KOBE**

# NATIONAL PETROLEUM SITUATION

**MORE MOTOR FUEL.** Stocks of motor fuel are 9 per cent above a year ago. End of war in Europe has materially changed demand picture and points to early easement in civilian gasoline supply. July demand apparently dropped about 100,000 bbl. daily, reflecting shift in war requirements from land to sea fighting, placing greater emphasis upon fuel oils.

**PEAK PRODUCTS DEMAND.** Demand for all refined products in first 7 months of this year is estimated at 5,379,000 bbl. daily, compared with 4,815,000 bbl. in corresponding period of 1944. Substantial part of this peak demand has been supplied by imports. Despite record refining operations, which approximated 5,000,000 bbl. daily in July, stocks of all products have shown substantial depletion. Still runs in first 7 months were about 3 per cent below operations needed to provide for depleted stocks.

**SLUMP IN DEMAND LIKELY.** End of war with Japan cannot fail to bring a sharp slump in domestic crude demand. Analysis predicated on end of hostilities points to drop in crude demand of approximately 1,000,000 bbl. a day. First post-war year, 1946, will bring severe cut-backs in production of many fields and substantial reduction in refining operations. It is likely that adjustments to peace-time operations will not be offset by increased domestic demand for many months, which cannot fail to work temporary hardships upon producers and refiners. New cars and tires for old cars hold the keys to the oil industry's post-war demand.

**DRILLING SITUATION IMPROVED.** The industry drilled 183 more wells in July than in June. Actual drilling results for the first 7 months of the year are now within easy reach of the quota. To date well completions aggregate 15,313, against a cumulative quota of 15,688. Removal of the uncertainty of the right of operators to deduct intangible development costs for income tax purposes, through passage by the House and Senate of Concurrent Resolution 50, is expected to spur exploratory efforts.

**TEXAS WILDCATTERS LEAD.** Wildcat drilling operations for first 7 months of year show increase of 241 over same period of last year. Texas has thus far contributed 169 more wildcats, which is 70 per cent of the increase in all Wildcats drilled in the nation.

**PROBABLE STOCK BUILD-UP.** War's end may result in a rapid accumulation of stocks of both crude and refined products. Sharp curtailment in demand for war products could quickly adjust working stock levels to normal needs. Primarily, reduced war demands will have the effect of automatically lengthening the days supply represented by present inventories. Today's crude stocks for example, constitute 43 days supply. If the industry's crude demand falls off 1,000,000 bbl. a day, these stocks would be sufficient to last 53 days. If production and refining schedules are gradually tapered off, the industry would quickly replenish any deficiencies in working stocks of crude and products.

## Comparative Statistics, July, 1945

*All figures are computed on a Bureau of Mines basis**

| | July 1945(p) | June 1945(p) | July 1944 | This year to date | Last year to date | Per cent change |
|---|---|---|---|---|---|---|
| Wells drilling | 4,150 | ¶4,120 | 4,130 | 4,150 | 4,130 | 0 |
| Total wells drilled | 2,532 | 2,349 | 1,985 | 15,313 | 11,916 | + 29 |
| Development wells | 2,168 | 1,970 | 1,611 | 12,942 | 9,786 | + 32 |
| Oil | 1,293 | 1,220 | 1,101 | 7,930 | 6,819 | + 16 |
| Gas | 248 | 210 | 214 | 1,417 | 1,170 | + 21 |
| Dry | 627 | 540 | 296 | 3,595 | 1,797 | +100 |
| Per cent dry | 28.9 | 27.4 | 18.4 | 27.8 | 18.4 | + 9.4 |
| Wildcat wells | 364 | 379 | 374 | 2,371 | 2,130 | + 11 |
| Oil | 54 | 32 | 49 | 323 | 260 | + 24 |
| Gas | 14 | 12 | 6 | 79 | 69 | + 14 |
| Dry | 296 | 335 | 319 | 1,969 | 1,801 | + 9 |
| Per cent dry | 81.3 | 88.4 | 85.3 | 83.0 | 84.6 | — 1.6 |
| Crude production | 153,175 | 146,810 | 141,287 | 1,024,177 | 954,844 | + 7 |
| Daily average | 4,941 | 4,894 | 4,558 | 4,831 | 4,483 | |
| Crude demand† | 160,689 | 154,740 | 150,550 | 1,063,984 | 988,998 | + 8 |
| Daily average | 5,183 | 5,158 | 4,856 | 5,019 | 4,643 | |
| Crude stocks | 222,730 | 226,172 | 229,689 | 222,730 | 229,689 | — 3 |
| Days supply | 43 | 44 | 47 | 43 | 47 | |
| Natural gasoline production | 9,975 | 9,695 | 8,767 | 66,514 | 57,695 | + 15 |
| Daily average | 322 | 323 | 283 | 314 | 271 | |
| Motor fuel production | 71,760 | 69,260 | 63,480 | 474,676 | 419,590 | + 13 |
| Daily average | 2,315 | 2,309 | 2,048 | 2,239 | 1,970 | |
| Gasoline yield, per cent | 40.8 | 40.8 | 38.9 | 40.7 | 38.8 | + 1.9 |
| Motor fuel demand | 69,985 | 72,465 | 64,857 | 473,149 | 414,607 | + 14 |
| Daily average | 2,315 | 2,415 | 2,092 | 2,232 | 1,947 | |
| Motor fuel stocks | 79,600 | 77,825 | 73,346 | 79,600 | 73,346 | + 9 |
| Days supply | 34 | 32 | 35 | 34 | 35 | |
| Fuel oil production | 62,820 | 66,600 | 59,648 | 432,264 | 406,115 | + 6 |
| Daily average | 2,026 | 2,220 | 1,925 | 2,039 | 1,907 | |
| Fuel oil demand | 57,330 | 61,385 | 55,166 | 461,628 | 425,981 | + 8 |
| Daily average | 1,849 | 2,046 | 1,780 | 2,177 | 2,000 | |
| Fuel oil stocks | 74,575 | 66,885 | 88,924 | 74,575 | 88,924 | — 16 |
| Days supply | 40 | 33 | 50 | 40 | 50 | |
| Refinery still runs | 154,875 | 148,960 | 143,434 | 1,025,589 | 953,294 | + 8 |
| Daily average | 4,996 | 4,965 | 4,627 | 4,838 | 4,485 | |
| All refined stocks | 231,260 | 215,620 | 240,737 | 231,260 | 240,737 | — 4 |
| Days supply | 46 | 40 | 51 | 46 | 51 | |

*Unless otherwise stated all figures represent thousands of barrels.
†Domestic and foreign. ¶Revised.

## Economic Position of U. S. Petroleum Industry

*Seven months ending July, 1945*

| | Normal | Actual | Per cent of normal |
|---|---|---|---|
| Drilling*** (wells completed) | 15,688 | 15,313 | 98 |
| Production (daily crude output) | 4,963 | 4,831 | 97 |
| Refining (daily still runs) | 4,994 | 4,838 | 97 |
| Stocks (crude and refined) | 516,964 | 453,990 | 88 |
| Price of crude (per bbl.) | $1.99 | $1.22 | 61 |

## Crude Prices by States for July, 1945§

| | | | |
|---|---|---|---|
| U. S. average | $1.22 | Louisiana | $1.20 |
| Texas | 1.23 | Arkansas | 1.25 |
| California | 1.07 | New Mexico | 1.04 |
| Oklahoma | 1.17 | Mississippi | 1.10 |
| Kansas | 1.17 | Illinois | 1.37 |
| | | Other states | 1.89 |

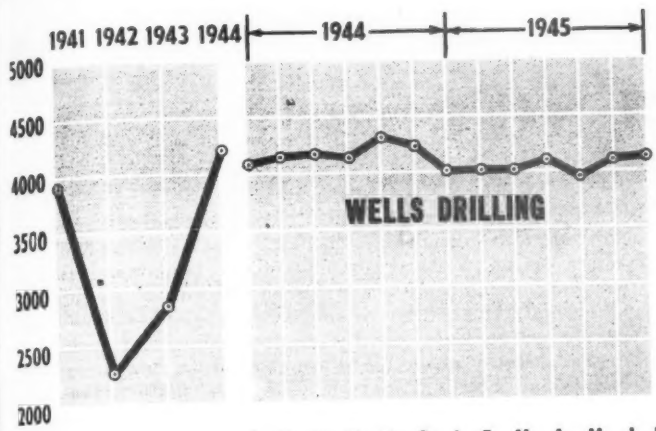
**Basic crude prices**

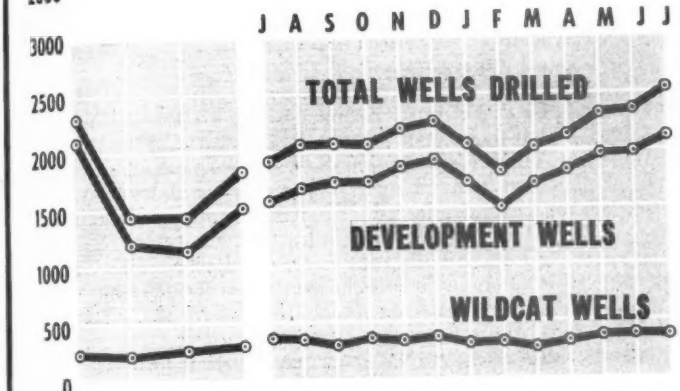
| | |
|---|---|
| Oklahoma-Kansas (36 gr.) | $1.17 |
| Texas Gulf Coast (36 gr.) | 1.40 |
| East Texas | 1.25 |
| West Texas (36 gr.) | 1.04 |
| Calif. Signal Hill (26 gr.) | 1.11 |
| Pennsylvania Bradford | 3.00 |

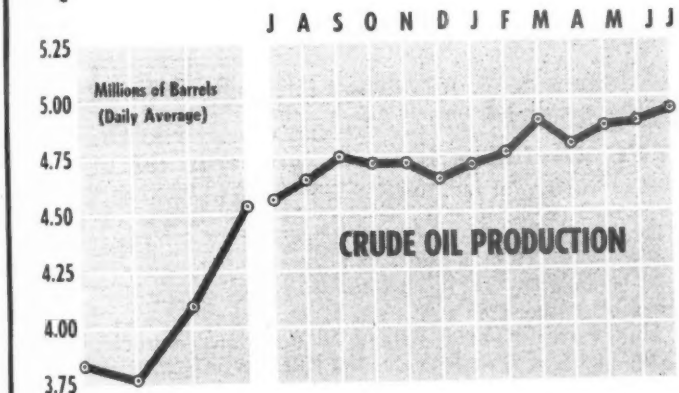
## Drilling and Production Statistics by States

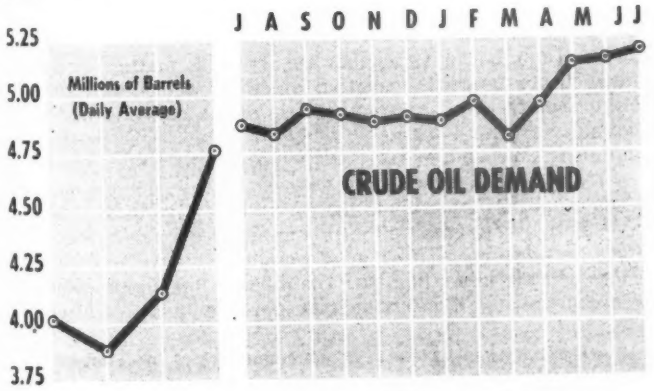
| | July 1945(p) | June 1945(p) | July 1944 | This year to date | Last year to date | Per cent change |
|---|---|---|---|---|---|---|
| Total wells drilled | 2,532 | 2,349 | 1,985 | 15,313 | 11,916 | + 29 |
| Texas | 633 | 611 | 517 | 4,119 | 3,040 | + 35 |
| California | 207 | 186 | 169 | 1,361 | 1,117 | + 22 |
| Oklahoma | 229 | 219 | 150 | 1,402 | 896 | + 56 |
| Kansas | 155 | 164 | 182 | 957 | 1,024 | — 7 |
| Louisiana | 89 | 124 | 74 | 637 | 420 | + 52 |
| Arkansas | 19 | 12 | 38 | 95 | 166 | — 43 |
| New Mexico | 31 | 27 | 26 | 248 | 234 | + 6 |
| Mississippi | 32 | 32 | 16 | 204 | 77 | +165 |
| Illinois | 166 | 155 | 163 | 960 | 958 | 0 |
| Other states | 971 | 819 | 650 | 5,330 | 3,984 | + 34 |
| Wildcats drilled | 364 | 379 | 374 | 2,371 | 2,130 | + 11 |
| Texas | 142 | 131 | 119 | 933 | 764 | + 22 |
| California | 24 | 26 | 36 | 138 | 131 | + 5 |
| Oklahoma | 35 | 45 | 37 | 260 | 197 | + 32 |
| Kansas | 28 | 42 | 44 | 217 | 289 | — 25 |
| Louisiana | 19 | 19 | 10 | 104 | 79 | + 32 |
| Arkansas | 3 | 2 | 5 | 25 | 34 | — 26 |
| New Mexico | 6 | 5 | 1 | 41 | 39 | + 5 |
| Mississippi | 11 | 9 | 13 | 72 | 51 | + 41 |
| Illinois | 39 | 39 | 42 | 196 | 198 | — 1 |
| Other states | 57 | 61 | 67 | 385 | 348 | + 11 |
| Daily crude production | 4,941 | 4,894 | 4,558 | 4,831 | 4,483 | + 8 |
| Texas | 2,206 | 2,184 | 2,074 | 2,174 | 1,972 | + 10 |
| California | 952 | 947 | 852 | 922 | 833 | + 11 |
| Oklahoma | 388 | 393 | 327 | 377 | 333 | + 13 |
| Kansas | 269 | 269 | 264 | 268 | 271 | — 1 |
| Louisiana | 355 | 359 | 346 | 355 | 352 | + 1 |
| Arkansas | 80 | 79 | 79 | 80 | 80 | 0 |
| New Mexico | 103 | 104 | 105 | 104 | 111 | — 6 |
| Mississippi | 51 | 51 | 44 | 51 | 42 | + 21 |
| Illinois | 215 | 212 | 206 | 209 | 213 | — 2 |
| Other states | 322 | 296 | 261 | 291 | 276 | + 5 |

§No change since prices frozen. Prices do not include subsidies.
(p) Preliminary. ***Does not include input wells.

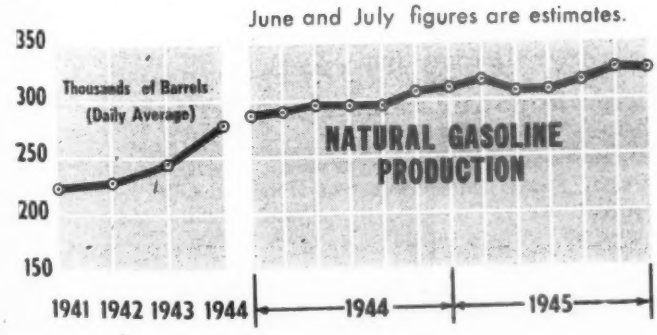


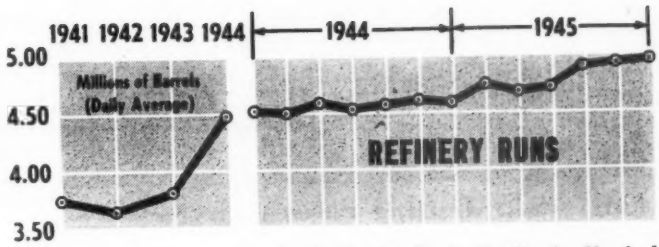



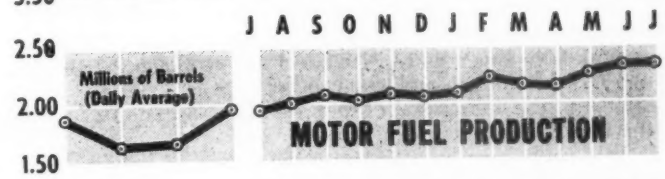



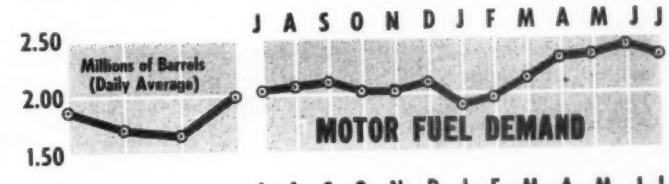



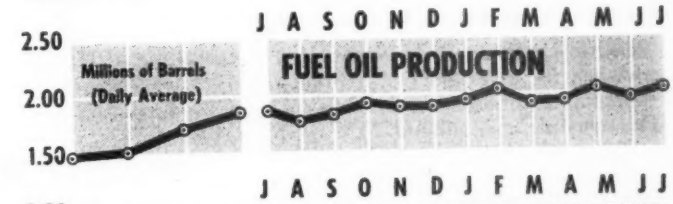

June and July figures are estimates.

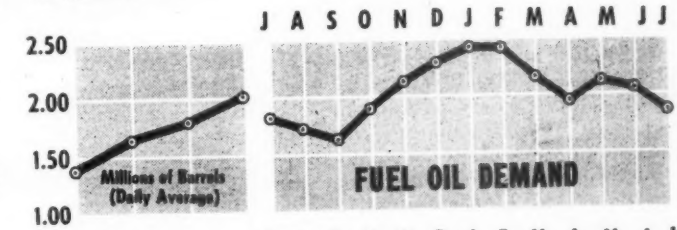


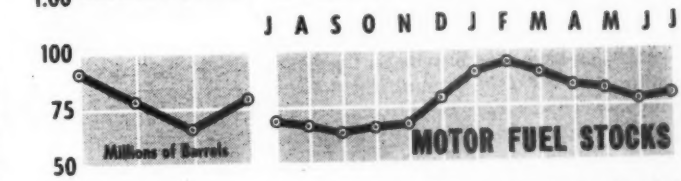



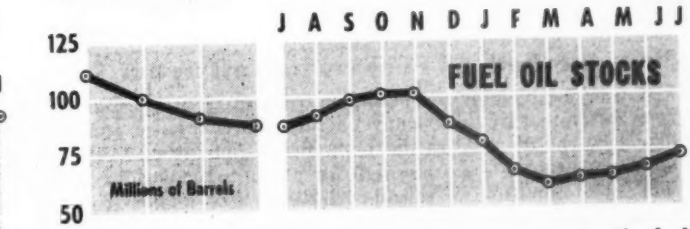



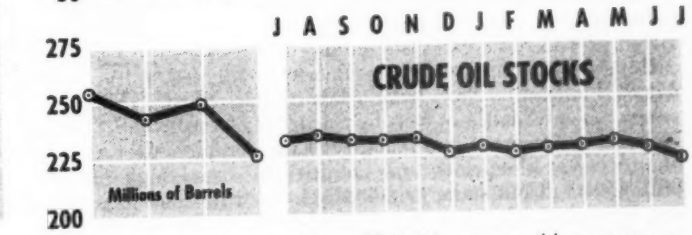



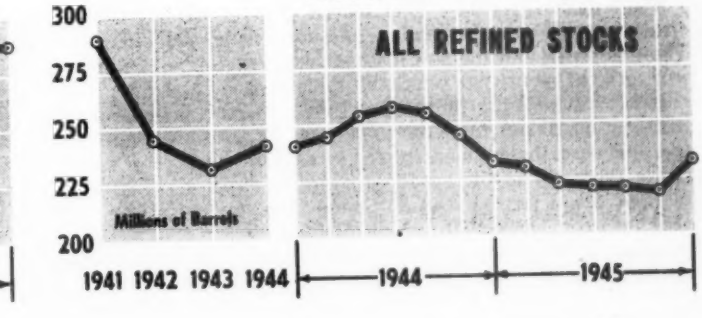




Years 1941-44 are monthly averages.



# *Highlights* IN OILDOM

## California drilling rules relaxed

Drilling rules for California were relaxed somewhat by Petroleum Administration for War in a recent order. The action was taken by amending Order No. 4 to Petroleum Administration Order 11. The most important change is a revision of Exhibit A of the order, which lists proved California oil fields and specifies well-spacing regulations for each.

New pools have been added to the listing in Exhibit A and some that were previously classified as single pools have been divided into more than one pool.

In addition, the order has been amended to provide minor relaxation of boundary-line limitations for new wells on 5-acre spacing, and to remove restrictions on installations of pumping equipment in existing wells.

## Drillers protest tax on rigs

Drilling contractors have protested the schedule of rates established for assessment of drilling rigs in Mississippi by the State Tax Commission and assessors of oil-producing counties. The schedule is as follows:

Diesel and diesel-electric rigs capable of drilling to depths greater than 7500 ft., $45,000; steam rigs drilling more than 7500 ft., $40,000; diesel and diesel-electric rigs, 5000 to 7500 ft., $30,000, and steam rigs, 5000 to 7500 ft., $25,000.

Bernard L. Tighe, Jr., attorney for drilling contractors, has protested that assessments are higher than those that have been in force, and says that the minimum rates are higher than maximum rates of any other oil state.

Assessors explained that under law they have no choice but to evaluate all property equally but that other states have legislation that is designed to take care of oil drillers.

Tighe cited figures obtained from tax commissions of other states showing that in none is the heaviest type rig assessed for more than $20,000. Among the maximum assessments per rig cited were: Arkansas, $10,000; Colorado, $13,500; Illinois, $7,500; Louisiana, $15,000; Kansas, $18,000; Wyoming, not over $20,000 on new rigs; Oklahoma, $16,000, and Texas, $15,000.

## New method of recovering oil from shale

A new method for extracting petroleum from oil shale has been developed by the Socony-Vacuum Oil Company, Inc., and placed at the disposal of the U. S. Bureau of Mines. Although the extraction costs are too high for present commercial operations in competition with crude oil, the method makes available to the nation when necessary an estimated 90 billion bbl. of petroleum, or more than four times the nation's present estimated proved reserves, it is announced.

Representing intensive experiments conducted at the company's Paulsboro, New Jersey, laboratories during the last 2 years, the information given by Socony-Vacuum to the Bureau includes engineering and technical data, complete descriptions of processes, blueprints, and facilities for developing the 400 billion tons of oil shale, principally located in Colorado, Utah, and Wyoming. The shale, now mined at the surface only, varies in oil richness.

Some authorities have long feared that the depletion of our crude oil will someday endanger our national self-sufficiency. These deposits and the new method for extracting oil from them will serve as security to offset this danger, it is pointed out.

It is estimated that mining and crushing the shale probably will cost $2.20 per ton—too expensive for present commercial use, but nevertheless a safeguard in case of shortage of natural crude should send the crude price up to $3.75 or $4.00 a bbl. In their experimental studies, Socony-Vacuum scientists recovered between 17 and 40 gal. of oil from each ton of shale, depending on operating conditions, the highest yield representing 15 per cent by weight of raw shale.

Overcoming many of the difficulties that have discouraged the recovering of oil from shale, Socony-Vacuum's method employs a retort, or long vertical container, 67 ft. high, which departs from conventional processes in that shale is preheated at 500°F. by the countercurrent flow of hot gases that sweep the oil vapors from the retort. Consequently, agglomeration and sticking of the solid material in the retort are avoided. In comparison with conventional retorting methods where the shale is heated in individual batches by external firing of metal or refractory vessels, the Socony-Vacuum method is a continuous flow and is said to be more efficient, offering excellent possibilities for reduced retort investment and maintenance.

The principle of the Socony-Vacuum retorting operation consists of passing the crushed raw shale down through a tower countercurrent to a stream of heating gases raising the temperature of the shale to about 1000°F. After the shale is fed to the top of the retort through a suitable feed leg, it flows by gravity. The heating gases are introduced at the bottom of the retorting zone. The oil vapors and escaping gases are taken off at the top of the retort and the oil is recovered in a series of condensers. The spent shale is withdrawn from the bottom.

Low pressure steam is introduced just above the spent shale drawoff to cool it and recover heat for retorting.

Crude shale oil recovered from the retorting process is very waxy, highly unsaturated, and high in sulphur and nitrogen.

Approximately 60 per cent of the oil was recovered in a hot (300°F.) condenser and the remaining 40 per cent was recovered as an emulsion with condensed steam in a water-cooled condenser at 65°F., the emulsion being easily broken in a centrifuge to obtain water-free oil.

## FPC disclaims it seeks gas control

The petroleum industry has been informed by the Federal Power Commission that the FPC does not seek to extend its controls to cover natural gas production or to include crude oil production and petroleum pipe lines. Neither does the FPC, it said, desire to invade what are properly regarded as the functions of conservation authorities of the several states.

In a formal letter to William R. Boyd, Jr., chairman, Petroleum Industry War Council, the FPC Chairman Basil Manly charted the scope of the course to be pursued by FPC in scheduled hearings on the natural gas industry:

"While the outline of the natural gas investigation necessarily covers a number of topics that are obviously matters of state or local concern, such information is being sought in order to provide a complete and correct picture of the entire industry and not as a basis for asserting or seeking any measure of regulatory authority over such matters on the part of the FPC.

"It seems desirable therefore to declare in unequivocal language that the Commission has no desire or intent to extend its jurisdiction as regards either oil production or petroleum pipe lines. In addition to other good reasons, we have enough headaches already in dealing with the difficult but highly important problems related to interstate transportation and sale of natural gas.

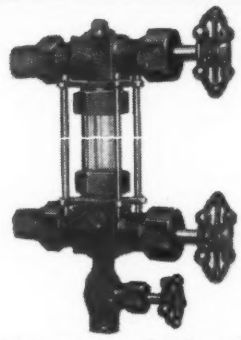
"We are seeking facts regarding matters of vital importance to the entire nation and are glad that the petroleum industry, as represented in the PIWC, is arranging through appropriate committees to present such evidence and views as it considers of importance to the investigation."

## Atomic power remote competitor

About 50 per cent of the petroleum industry's annual output is safe from competition from atomic power, according to Dr. Gustav Egloff, chief chemist of Universal Oil Products Company, Chicago. He stated that almost half the industry's production is utilized for purposes other than power.

He said further: "Atomic power, as an economically competitive substitute for gasoline for ships, planes, cars, and other vehicles, still appears on the long road ahead."

# PENBERTHY
## "ALL IRON"
## WATER GAGE SET



Extra heavy construction throughout. Body made from special high strength alloy iron, shanks alloy steel and trim stainless steel. Automatic and positive shut-off if glass breaks, valves self-cleaning, dripless drain cock permits gradual blowing off of gage. Conforms with A.P.I.-A.S.M.E. requirements.

The Heavy Duty "All Iron" is one of the complete line of Penberthy gages that meets every liquid level gage requirement.

PENBERTHY INJECTOR CO.
DETROIT 2, MICH. Canadian Plant WINDSOR, ONTARIO

# PENBERTHY
## "REFLEX"
## WATER GAGE SET

For oil field, locomotive type and marine boilers. Water shows black — steam shows white; the water level is unmistakable. U-Bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler. Conforms with A.S.M.E., Federal and State requirements when used for pressures specified by their respective codes.

This is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

# PENBERTHY
## "NAVY TYPE"
## WATER GAGE SET

Extra heavy construction made of "Navy Bronze Composition M." Important features include: regrinding valves, automatic and positive shut-off if glass breaks, valves self cleaning, glass offset from stems to allow cleaning from either end without loosening packing. Conform with A.P.I.-A.S.M.E. requirements.

The "Navy Type" is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.
DETROIT 2, MICH. Canadian Plant WINDSOR, ONTARIO

# PENBERTHY
## EJECTORS

Use the power of steam, air or water under pressure to lift liquids. Being simple jet pumps they have no moving parts and require no lubrication. A variety of models to meet different conditions. Also used as water heaters.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

# PENBERTHY
## AUTOMATIC INJECTORS

The accepted method for assuring an uninterrupted supply of feed water to oil field boilers. Penberthy Automatic Injectors will supply feed water to boilers at minimum cost, are quickly and easily installed, reliable under most severe operating conditions, require little attention and no careful handling. Highest quality design and rugged construction.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

# PENBERTHY
## SUMP PUMPS

Used wherever seepage water accumulates, the Penberthy Automatic Electric Sump Pump and the Penberthy Automatic Drainer (water or steam operated) have demonstrated their superiority in this service. Simple and rugged design—copper and bronze construction throughout.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

# MAJOR *Oil Field* ACTIVITIES

● **LOUISIANA.** Noble and Baker have opened a new deep oil pool in the South St. Gabriel sector of Iberville Parish, Southern Louisiana, with No. 1 W. E. Caldwell. Drilled to 9305 ft., the casing was perforated with 114 shots from 9190-211 ft., and on preliminary test flowed an estimated 150 bbl. of 37.9-gravity oil. The new discovery is approximately one mile south of the St. Gabriel gas-condensate pool.

*Humble Oil and Refining Company has opened an oil pool in the Bayou Cardin sector of St. Mary Parish, southern Louisiana. The well is No. 1-B Miami Corporation, which, on a one-hour test, flowed at the rate of 264 bbl. of 34.8-gravity oil daily through tubing choke. The well is flowing through casing perforations opposite 22 ft. of oil sand from 11,600-611 ft.*

● **OKLAHOMA.** A prospective pool opener is The Texas Company No. 1 Arundel, SE NE SW, 2-15-1w, near Evansville, southeastern Logan County. Situated equally between the Meridian pool in southern 16-1w, Logan County, and the Northeast Arcadia pool, Oklahoma County, the new discovery has the dry Wilcox sand from 5805-5923 ft. Operators perforated opposite the Chicken Farm of the Bartlesville sand at 5231-5243 ft. and recovered 3200 ft. of oil and oil-cut mud in 180 minutes. Testing is continuing.

Cities Service Oil Company and associates have opened a new oil pool in McClain County south of Oklahoma City with their No. 1 Lawson, long a mystery well. The well, completed in 22-5n-4w at 10,990 ft., produced through a small choke at the rate of more than 50 bbl. of 44.7-gravity oil per hour. Gas flow of the well was estimated at 7,000,000 to 8,000,000 cu. ft. The new pool is on the southwestern tip of the Anadarko-Panhandle Basin, one of the major geological oil structures in this country.

Superior Oil Corporation of California has a prospective pool opener with No. 1 Manning, NE NE NW, 27-22n-10, near Ringwood. Drilled to 8239 ft., in the Wilcox sand, the hole was apparently dry and was plugged and cemented at 6721-45 ft., in what field men say is the Mississippi lime. The well was producing 5 to 10 bbl. of high-grade fluid per hour with 1,000,000 ft. of gas.

Gulf Oil Corporation appears to have opened a Wilcox producer in Garfield County with No. 1 Decker, SE SW NW, 12-20-4w. The well had the Wilcox at 6078 ft. and was drilled to the second Wilcox at 6119 ft., total depth. It cleaned out to 6100 ft. and swabbed 122 bbl. of oil, free of water and contamination. Testing showed some gas.

The No. 1 Rose, wildcat of the L. B. Jackson and Deep Rock Oil Corporation, near Dale, is a possible pool opener in the Wilcox sand. In NW SE NE, 26-11n-2e, the well had the Wilcox at 5804 ft. and on core test from 5807-12 ft., showed good production prospects. Tests in the Simpson sand showed good stains and operators were continuing to test.

● **NEW MEXICO.** Federal-Penrose No. 1, the Ellenburger discovery for the Penrose field is drilling to 8286 ft. in the granite-wash. Neville Penrose, Inc., operators, say that the overlaying 252-ft. section of Ellenburger will make a prolific producer.

● **KANSAS.** Continental Oil Company No. 1 Brown, NE NE NE, 33-3-27w, a wildcat about 14 miles north of the Adell pool, Sheridan County, has set pipe for testing at 3767 ft. Total depth is 3982 ft. Fair stain and porosity was logged in the Lansing at 3522-29, 3561-65, and 3617-28 ft. and operators believe the well will be completed as a commercial producer.

J. M. Huber Corporation No. 1 Roard, NE SW NE, 9-31-14w, a wildcat, is testing after a 1700-ft. fillup of oil from perforations in the Maquoketa at 4363-65 ft. The well is 4 miles from commercial production.

No. 1 Cromb, a wildcat of Darby and Bothwell, Inc., shows for a possible pool opener in Ellis County. Situated in NE NW NW, 22-11-20w, the well had the Lansing lime at 3374 ft., the Kansas City lime at 3590 ft., and the Simpson sand at 3669 ft. The Arbuckle lime was found at 3680 ft. and oil showings were recovered from 3682-85 ft.

● **INDIANA. New triple-pay well in Posey County is Texas Company's No. 1 J. L. Larkin, SE NE SW, 16-6s-14w, 4½ miles northwest of Mt. Vernon. The Hardinsburg sand is from 2322-28 ft. and on a 2-hr. drillstem test, 40 ft. of gas, 640 ft. of clean oil, 60 ft. of drilling mud and 120 ft. of salty mud and water were recovered. The second commercial pay is the Lower O'Hara limestone, 2810-19 ft. In 20 minutes, 2760 ft. of clean oil and 60 ft. of oil-cut mud were recovered. From 2889-96 ft. is the McClosky limestone that also showed for commercial oil production. Operators plan to drill to the top of the St. Louis limestone and set pipe on the McClosky lime with alloy pipe opposite the O'Hara and Hardinsburg formations.**

● **ILLINOIS.** The best pool opener in the Illinois Basin in the past few weeks is the No. 1 Halleck Jones, NE NE NE 22-7s-9e. R. J. Freyer, Frank W. King, Jr., Paul Holleman and R. S. Hays, operators, drilled to 2904-12 ft. where the well showed for a pool opener in the Aux Vases sand. The first 24 hr. after the cement plug was drilled on this discovery well, the gage showed 402 bbl. of oil. New locations have been staked in the area.

Southwest of the Johnsonville pool in Wayne County, Carter Oil Company has opened a good producer with its No. 2 T. Weaver, SE NW NW, 19-1s-6e. The McClosky limestone in this well is commercial as well as the lower O'Hara. The latter is found from 3122-32 ft., and the McClosky from 3172-84 and from 3196-3200 ft. Total depth is 3200 ft. The initial production given this well is 696 bbl. of oil in 24 hr.

Sam A. Gilpin and C. E. Brehm have a commercial-looking well in No. 1 S. V. Bayley, NW SW NE, 3-7s-9e, a mile and a half southwest of Herald in White County. The casing has been set on the Cypress sand, 2682-95 ft. that showed free oil and oil-cut mud on drillstem test.

● **OHIO.** *Ohio Oil Company's No. 1 D. B. McCuen, Mahoning County is showing for a commercial producer in the Oriskany at 3608-26 ft. Situated near the town of Goshen, the wildcat is producing 3,980,000 cu. ft. of gas per day. Total depth is 3636 ft.*

● **TEXAS.** Colorado County has a new gas-condensate pool half a mile north of Altair with No. 2-A Tait of Superoir Oil Company. The well flowed 440 bbl. of 57-gravity condensate with an ungaged amount of gas from perforations at 8256-68 ft.

Ambassador Oil Company and Roeser-Pendleton Oil Company No. 1 McAnalley opens a new pool for Jack County. It is 7 miles southeast of Jacksboro. On a 30-minute drillstem test, the well showed 240 ft. of pipe line oil and 520 ft. of heavy oil-cut mud. Nearest production is Continental No. 1 Risch, more than 2½ miles to the east.

In Austin County at Sinclair Oil and Refining Company No. 3 Schweke, operators were running casing at 10,013 ft. for what appeared to be production at 9155-68 ft. The wildcat, 2 miles southeast of New Ulm, recovered 500 ft. of 36-gravity oil on drillstem test. It also had a show of gas-condensate around 9700 ft.

Brooks County's latest prospective wildcat field discovery is the Sun Oil Company No. 5 Sullivan. Total depth of the well is 9927 ft., and operators ran drillstem tests in 54-hole perforations at 7676-85 ft. after setting oil string at 9477 ft. No results of the tests have been released.

Stanolind Oil and Gas Company has opened a new Permian lime oil pool in southwestern Cochrane County, 14 miles west of the Slaughter pool and north of the Yoakum County line. The discovery has been completed to flow 385 bbl. of oil in 24 hr. from a total depth of 5080 ft.

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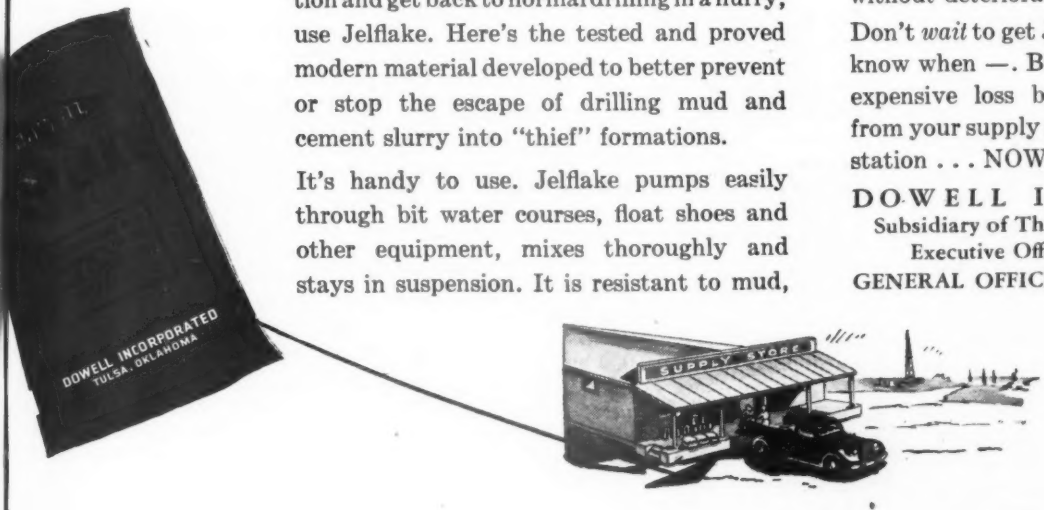


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# MAJOR *Refining* ACTIVITIES

● **PURE OIL PROJECT.** Pure Oil Company is planning to build a petroleum coke plant at Toledo, Ohio, to cost in excess of $1,000,000, as soon as materials can be obtained. The plant is expected to be used as a standby unit, for use when economic conditions in the industry make it more advantageous to conduct coking operations than to produce fuel oil. Designing and engineering work on the plant is complete and it is awaiting approval from Washington.

● **TRIPOLI PLANTS. Socony-Vacuum Oil Company, Inc., and the Standard Oil Company of New Jersey have announced that the Lebanese government has given them permission to build two refineries at Tripoli, about 40 miles northeast of Beyrouth. The agreement provides that Lebanese labor must be employed except in highly technical capacities. Tripoli is the terminus of the northern leg of the existing double pipe line from Iraq oil fields to the Mediterranean.**

● **ADDITIONAL VENEZUELA FACILITIES.** Preliminary work has been started in Venezuela for a British-Dutch oil refinery that will cost about $30,000,000 and will have a capacity for processing 50,000 bbl. of crude oil daily. The site is near the village of El Cardon. The present program includes construction of 12 cement-block houses, a water and sewerage system, a stone dock for lighters and small boats, an airstrip for company planes, housing for supervisors, and some offices and warehouses. Actual work on the refinery will not begin until materials can be imported.

● **PLANT FOR VENEZUELA.** Turiamo has been selected for a refinery to be built by Creole Petroleum Corporation, subsidiary of Standard Oi Company of New Jersey. Situated about 20 miles from Puerto Cabello and some 50 miles from Caracas, Turiamo was chosen as the site after a two-year detailed study of water supply, harbor depth, living conditions, land contours, climate, food supply, disease incidence, and crude oil supply by Creole specialists.

Construction of the $50,000,000 plant will get under way before the end of the year and is scheduled for completion by the close of 1947. Construction will comply with provisions of the Venezuelan Oil Law of 1943 requiring foreign oil companies to refine a certain percentage of Venezuelan crude within the country. When completed, the plant will produce aviation and motor gasolines, kerosine, industrial lubricants, automotive and marine diesel fuels, greases, and asphalts.

Equipment is to be the most-up-to-date, including a new fluid catalytic cracker for producing 100-octane aviation gasoline. Crude from both eastern and western Venezuelan oil fields will be refined at Turiamo, which is situated midway between the Maracaibo basin and the Puerto de La Cruz pipe line terminal from the eastern fields. Storage tanks with a capacity for 4,000,000 bbl. and residence buildings for 8000 persons will be built by the company.

● **CYCLING PLANT.** Continental Oil Company has a cycling plant under construction in the Rincon field of Starr County, Texas, that will process 15,000,000 cu. ft. of gas daily. The plant, 40 miles northwest of McAllen, will begin operation next month.

● **ISOPRENE PLANT.** Shell Chemical Division of Shell Union Oil Corporation has announced that it is proceeding with plans for the construction and operation of a $2,000,000 isoprene recovery and purification project to be situated adjacent to the butadiene plant now being operated in the Los Angeles area by the company for RFC, Office of Rubber Reserve. Jan Oostermeyer, executive vice president of the company, in making the announcement, said that the proposed plant will be the largest single isoprene installation in this country, and, with its completion, the production capacity of isoprene under the government's synthetic rubber program is expected to double.

● **ADDITIONAL FACILITIES.** *Standard Oil Company of Indiana has built supplementary installations to its Casper plant to refine Elk Basin and other similar crude oil. With the additional facilities Standard will assist in meeting the greatly enlarged demand for bunker fuel on the West Coast. Production of bunker fuel for the Navy began August 1 and deliveries will be made as soon as necessary storage can be built up. About 1800 bbl. of bunker fuel per day are being produced.*

● **TEN MILLION BARRELS.** Continental Oil Company has announced that it has refined 10,000,000 bbl. of petroleum products and 2,000,000 bbl. of 100-octane gasoline since Pearl Harbor. Dr. Walter Miller, vice president of Continental in charge of manufacturing said that the total 10,000,000 bbl. includes more than 300,000 bbl. of toluene for TNT and as a blend for 100-octane gasoline and about 750,000 bbl. of lubricating oils. The company received congratulatory telegrams from General of the Army H. H. Arnold and Ralph K. Davies, deputy petroleum administrator, on its record.

● **SAFETY AWARDS.** In recognition of the safety records set in producing 100-octane aviation gasoline, toluene for TNT, and other petroleum products for the armed forces, employes of the Whiting, Indiana, refinery of Standard Oil Company of Indiana have received 16 safety awards from API. Each award recognized success in preventing accidents in a different department for 1,000,000 or more man-hours of work without loss of time or disabling injury. The awards for the most man-hours worked without disabling injury was presented to employes of the pressure stills department with a record of 5,476,776 hours covering 11½ years.

● **FRENCH PLANTS PRODUCE. Although refinery and storage installations for petroleum near Bordeaux, France, suffered severe damage, present facilities at Ambes, Hassens, and Pauillac are in condition to receive a total of 100,000 tons of petroleum, the foreign press has reported. Bordeaux may be able to handle 5,500,000 tons of petroleum annually when the entrances have been cleared, the report said.**

● **EAST TEXAS REFINERY.** Work has begun on an asphalt refinery at Big Sandy, southwestern Upshur County, just east of the Hawkins Woodbine sand pool in southeast Wood County. The plant, being built by Rogers Lacy, will have a capacity of 3500 bbl. of crude oil daily to be supplied with crude from the low-gravity Hawkins pool by independent operators. The $500,000 plant will produce 1200-1500 bbl. daily.

● **GASOLINE PLANT.** Lone Star Production Company has been granted permission by WPB to build a $936,000 natural gasoline cycling plant in the Chapel Hill pool of Smith County, East Texas. The pool produces from the Rodessa section of the Glen Rose and from the Pettit lime and Travis Peak sand of the Basal Trinity. The plant will have a daily capacity of 55,000,000 cu. ft. with a reinjection capacity of 35,000,000 cu. ft. Shell Oil Company had originally obtained permission for this plant but was unable to obtain equipment and transferred the permit to Lone Star.

● **WORK HALTED.** Work has been stopped on a toluene plant under construction at Borger, Texas, RFC has announced. The action was taken at the request of the war department. The cost of the plant was estimated at between $4,000,000 and $6,000,000 and about 10 per cent of the work had been done. The plant was to have been owned by RFC and operated under lease by Phillips Petroleum Company.

● **PLANT REBUILT.** Germany's largest oil refinery near Hannover has resumed production after being rebuilt, according to the Berlin radio. The bombed-out Schleura plant is now supplying 25 power stations and other former coal industries, according to the report.

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# MAJOR *Pipe Line* ACTIVITIES

● **RENEW EFFORTS.** Renewal of the fight to sell Texas natural gas to industrial consumers in Monterrey, Mexico, is being made since the opening of a new 82,000,000 cu. ft. well southeast of McAllen. The Reynosa Pipe Line Company application to build a pipe line to carry 60,000,000 cu. ft. of gas daily to Monterrey for 10 years is set for rehearing before FPC October 3. Recently the corporation refused to grant permission for the company to build.

● **EMINENT DOMAIN RIGHTS.** **President Truman has granted The Texas-Empire Pipe Line Company the right of eminent domain for acquisition of land in the Logan, DeWitt, and McLæan counties, Illinois, for a pipe line. The company is building the artery, described as necessary to national defense, from Cushing, Oklahoma, to Heyworth, Illinois. By proclamation the president declared that the company could acquire right-of-way needed on its projected route through the three Illinois counties for a length of approximately 17 miles and a width not to exceed 50 ft. The acquisition right runs until June 30, 1946.**

● **GAS LINE.** United Gas Pipe Line Company has been granted permission by FPC to construct a 24-in., 143-miles pipe line to run from Carthage field, East Texas, to Monroe, Louisiana. The artery will connect with the Tennessee Gas and Transmission Company's existing 24-in. line at Monroe and then with United's existing facilities in the Monroe field. With a daily capacity of 310,000,000 cu. ft. of gas, the line will transport for the Tennessee company a maximum of 114,000,000 cu. ft. daily from the Carthage field to Monroe's compressor station. The Texas Railroad Commission has asked FPC to reconsider the approval contending that public convenience and necessity does not justify the new pipe line and that Texas must conserve its natural resources for its own future development.

● **FAVORS PIPE LINE.** District 3 Petroleum Industry Committee has recommended construction of a 14-in. oil pipe line from Monahans, Permian Basin, West Texas, to the Los Angeles, California, refining area. The proposed line, which for some time has been the subject of discussion among oil men, would be 986 miles long and have a daily capacity of 50,000 bbl. of oil. The committee estimated that about one year would elapse before the proposed artery could be placed in operation. Competent engineers calculate that the line can be laid in from 4 to 6 months, L. M. Glasco, secretary-treasurer of the Pacific War Emergency Pipelines, Inc., said. The first estimate allows time for processing the application, granting priorities, manufacturing, and shipping the pipe and other materials, making necessary surveys, purchasing the rights-of-way, and assembling construction crews and equipment, installing pipe and stations.

"If someone with the authority to do so will cut the red tape, we can get busy at once, build the line and ease the strain on the overtaxed railway lines that are hauling 13,000 tank cars of petroleum to the West Coast," Glasco said.

Olin Culberson, chairman of the Texas Railroad Commission, who had previously openly advocated the building of such a line, has appealed to President Truman and Senator James M. Mead, chairman of the United States Senate War Investigating Committee, to use their influence in getting permission to construct the carrier.

● **ODT AUTHORIZATION.** The use of railway tankcars for short haul movements of liquid commodities for distances as low as 80 miles in 42 states has been authorized by ODT. Previously, railway tankcars could not be used without a special permit. The mileage reduction in tankcar movement is effective through December 21, 1945.

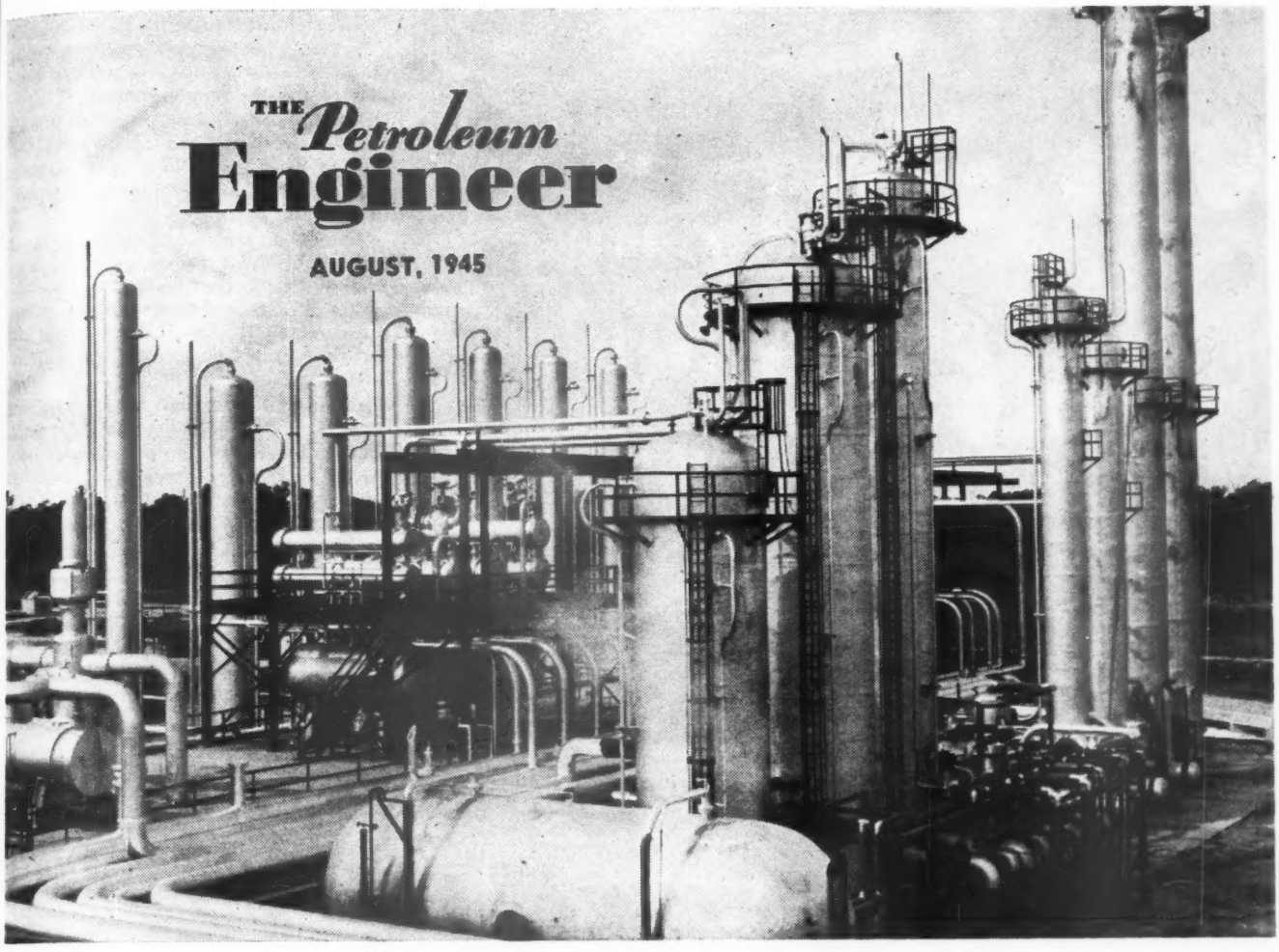
● **SUN OIL LETS CONTRACT.** J. R. Horrigan Construction Company has been awarded the Sun Oil Company contract to lay 26 miles of 4, 6, and 12-in. pipe line from the Delhi Paluxy sand pool of Richland Parish, North Louisiana, to a barge loading terminal at Talla Bena, on the west bank of the Mississippi River. This will be the first outlet for the pool, which originally was classified as producing from the Tuscaloosa sand, widely productive in southern Mississippi. The Delhi pool later was classified as producing from the Paluxy sand of the Upper Glen Rose.

● **GREAT LAKES PROJECT HELD.** Great Lakes Pipe Line Company is holding in abeyance its $6,000,000 products pipe line expansion program awaiting necessary materials. The plan ran into difficulty with PAW and was withdrawn by the company with permission to refile the petition to build. Officials are expected to resubmit the plans when tankcar transportation is tightened up, on withdrawal of tankships from coastwise service, and it is believed under those conditions it will be approved. If not, the line will be built when pipe is available. The project will be 800 miles long and will be laid with 8-in. pipe. It will extend from Barnsdall, Oklahoma, to Kansas City, Missouri, and an 8-in. extension will be laid from Kansas City to Omaha, Nebraska, Sioux City, Iowa, and Sioux Falls, South Dakota. The entire project is viewed as a definite postwar development.

● **EAST TEXAS OUTLET.** First line for the Sand Flat Paluxy pool, northern Smith County, East Texas, is being planned by Humble Pipe Line Company. It will build a 6-in. line from the field to extend northeast to connect with its Hawkins-Longview carrier, which is 10 in. in size. The Sand Flat pool was discovered in 1944 and has been without a pipe line since that time, depending upon tankcar shipment. Lack of transportation has curtailed development of the area.

● **PERSIAN ARTERY.** *The Texas Company and Standard Oil Company of California jointly have formed a second Arabian corporation to construct a pipe line from the Persian Gulf to the eastern end of the Mediterranean. Negotiations for rights-of-way are now in progress but it has not been determined whether the Trans-Arabian Pipe Line Company or the Arabian American Oil Company will hold title to them, W. S. S. Rodgers, chairman of the board of The Texas Company, said. Shortages of labor and materials will impede immediate construction, but the line will be built as soon as circumstances permit, Rodgers said. Stock of the Trans-Arabian Pipe Line Company is held equally by the two companies as is the stock of the Arabian American Oil Company, which now operates in Saudi Arabia.*

● **INDUSTRY OBJECTS.** The oil industry opposes the Bland ship sale bill because of the disparity in cost between tankers and subsidized and unsubsidized cargo boats. Under the bill, tankers can be purchased from the government at 75 per cent of prewar domestic cost, whereas subsidized and unsubsidized cargo boats can be bought at 55 and 50 per cent, respectively. The industry takes issue with the section of the bill providing that the purchase price shall be based on prewar domestic cost rather than on prewar foreign cost. It favors the latter basis because those prices would be lower and the less a company has to pay for a ship the better able it will be to meet foreign competition. An oil company member of the American Merchant Marine Institute's tanker committee said that Representative Bland's argument that tanker prices should be higher because they are "operated for the most part by industrial firms for the carriage of their own products," was "superficial." He added that the industry will probably be satisfied with the present trade-in values for tankers, both under the 90-day incentive period plan under which more liberal values are allowed, and with the old values outlined in the Merchant Marine Act of 1936, which take effect after the 90-day period.




Processing area—stills and fractionators on right, absorbers on left.

# WORLD'S LARGEST ABSORPTION PLANT

By **FRANK H. LOVE**
*Managing Editor*

**EXCLUSIVE** RECENT addition by J. S. Abercrombie Company and Magnolia Petroleum Company of a high pressure absorption unit to the existing recovery and pressure maintenance installation in the Old Ocean field, Texas, increases throughput of the plant to 350,000,000 cu. ft. of gas a day, the largest plant of its type in the world.

The new unit, in addition to increasing capacity, also steps up the efficiency of the absorption process. The plant now recovers 90 per cent of the normal butane and essentially 100 per cent of the isopentane and heavy material.

Other features claimed for the plant are: (1) It was the first to be designed for injection pressure as high as 5000 lb., and (2) it is believed to be the first utilizing absorption pressure as high as 2250 lb. Although this latter statement may be open to some question, it was among the first to operate at that pressure.

Products manufactured consist of deisopentanized natural gasoline, propane, isobutane, normal butane, and isopentane. These products are pumped to the Old Ocean refinery of the J. S. Abercrombie Company and Harrison Oil Company for use as components in the manufacture of aviation gasoline.

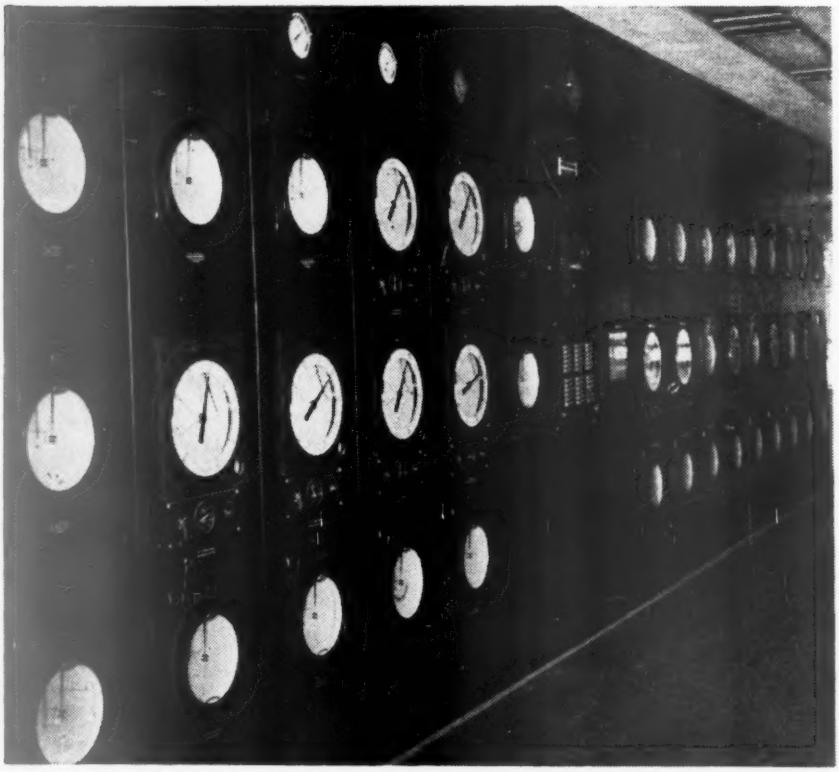
The complete installation was constructed over a period of years and consists actually of two interrelated plants. In 1939 the first section was built for the company by Stearns-Roger Manufacturing Company to make a straight natural gasoline line of 26-lb. Reid vapor pressure. In 1941, additions were made to separate isopentane and normal and isobutane, a deisopentanized natural gasoline being manufactured. M. W. Kellogg Company was the contractor. J. F. Pritchard and Company built the new high pressure unit, which will be discussed principally in this article.

Although nominally two plants on a common site and operating somewhat independently, the new plant nevertheless can make lean oil for the old plant and also can process a part of the old plant's raw gasoline stock.

● **New equipment installed.** Three stills are included as a part of the high pressure absorption installation. The high pressure still is 49 ft. high by 11 ft. in diam. and has 12 trays. Operating pressure is 185-200 lb. per sq. in. Top temperature is maintained at 250°F. and bottom temperature at 427°F. Temperature of oil entering the column is 435°F. The intermediate pressure still, which operates at 50-60 lb., is 66 ft. high, 12 ft. in diam. and has 18 trays. Rich oil enters the column at a temperature of 437°F. and leaves at 390°F. Top temperature on the still is 230°F. The low pressure still is 61 ft. high and 8 ft. in diam., with 24 trays. Temperature of the oil into the still is 390°F. Top temperature is 240°F. and bottom temperature 480°F. Working pressure is atmospheric to 5 lb.

The depropanizer column is 71 ft. high and 5 ft. in diam., having 24 trays. The column operates at 335 lb. per sq. in. gage and on it is maintained a top temperature of 130°F. and a bottom temperature of 320°F.

The debutanizer is 67 ft. by 5 ft. 6 in., has 24 trays, and operates at a pressure of 85-lb. gage. Bottom temperature is 280°F. and top temperature 130°F.



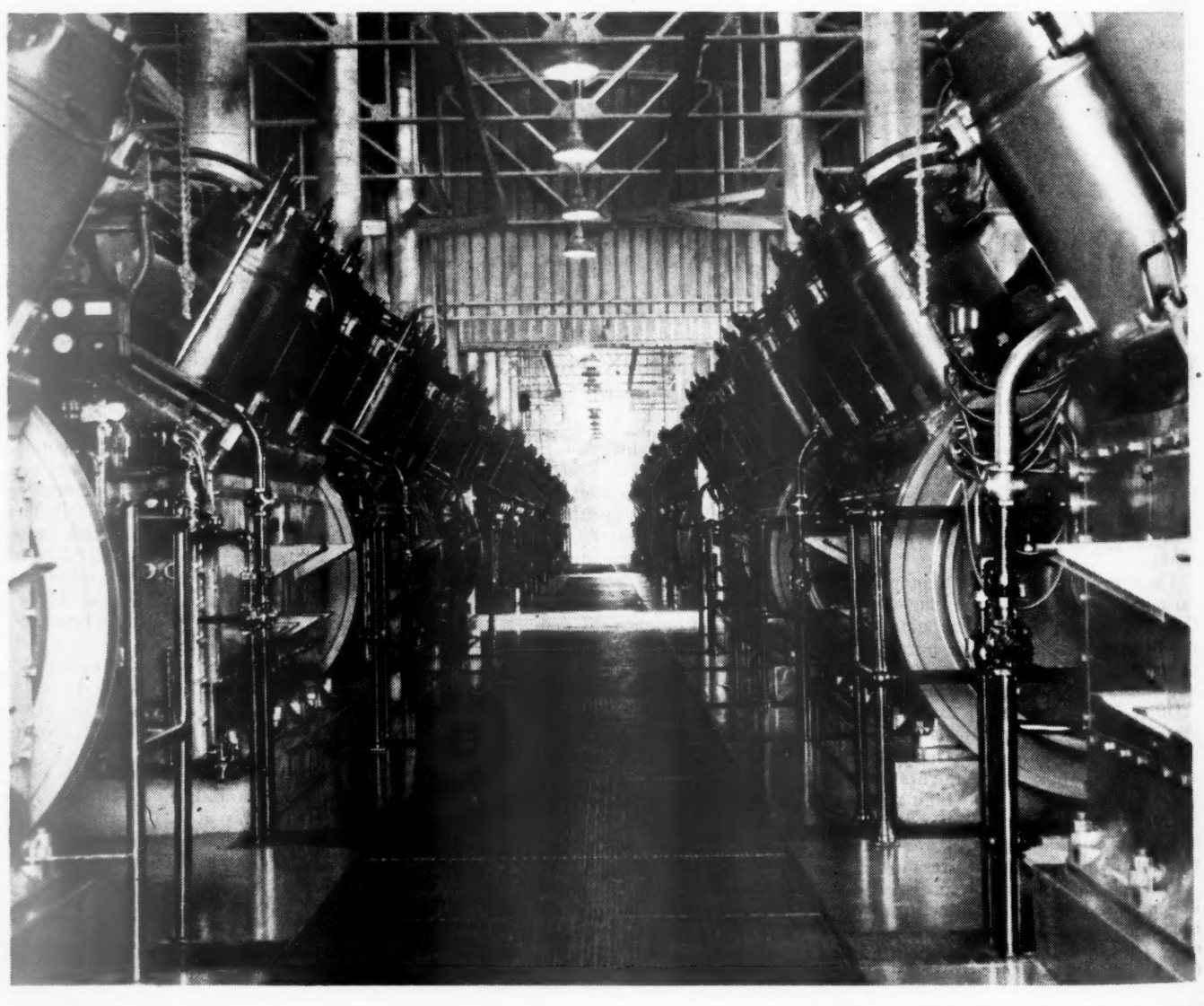
The deisopentanizer is 123 ft. high by 7 ft. diam., has 50 trays, and operates at 30-lb. pressure. Bottom temperature is 230°F. and top temperature 135°F.

The butane splitter also is 123 ft. high and 7 ft. in diam., and has 50 trays. Operating pressure is 85-lb. gage, bottom temperature 145°F., and top temperature 120°F.

Three 4-ft. diam. absorbers, designed for operation at pressures as high as 2250 lb., have been installed. One absorber is used interchangeably at that pressure and at 1250 lb. A 5-ft. diam. absorber operates at 1250-lb. pressure, a 5-ft. diam. absorber at 500 lb., another 5-ft. unit at 150 lb., and a 4-ft. diam. absorber at 50 lb. Absorption oil pumps consist of three 10-stage centrifugal units driven by 1380-hp. steam turbines.

To take care of the additional volume of dry gas being injected to the producing formations, six new 600-hp. V-type single-stage compressors have been installed. This makes a total of 22 such units having a total horsepower of 13,200. Discharge to injection wells is at a pressure of 3700 lb., although design is such that a discharge pressure as high as 5000 lb. is possible.

***Above*—Control board. *Below*—Six new 600-hp. V-type single-stage compressors are being installed, making a total of 22.**



Auxiliary appurtenances, such as cooling towers, pumps, generating equipment, product storage, heaters, condensers, various drums and other essential vessels and equipment, which will be discussed later, complete the new plant installation.

● **Plant design.** The new plant is built on the order of a refinery installation, i.e., units are grouped in a smaller area than is usual for absorption plants. Reflux drums are situated on a concrete platform above the pumphouse, and on another platform above the drums are the condensers. On one side of the pumphouse, in a single row, are the absorbers and on the other side the still and fractionating sections. The arrangement is shown in an accompanying photograph.

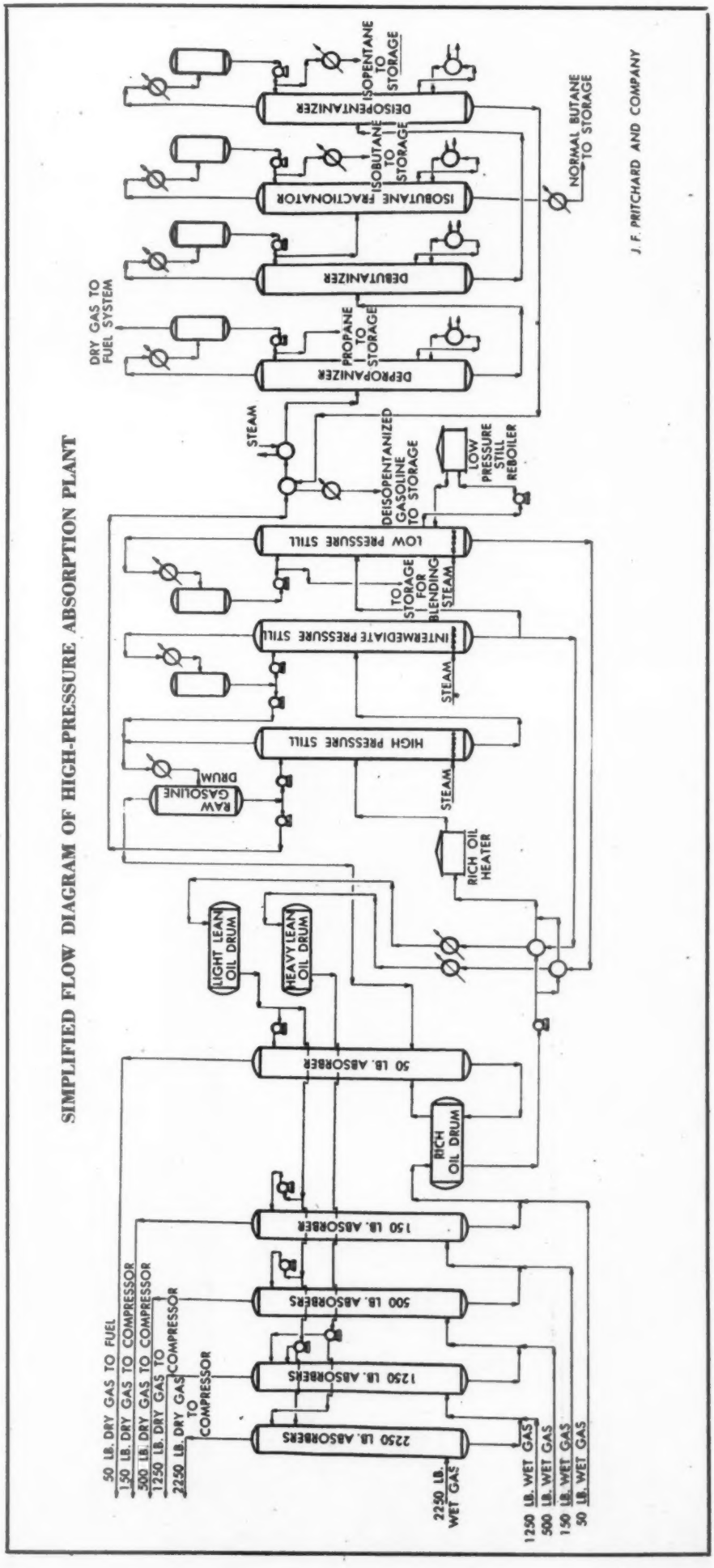
The absorption system differs from the method employed in most plants in two respects: (1) The high pressure absorbers utilize a double lean oil system, and (2) rich oil from the bottom of each absorber flows directly into the bottom of the next lower pressure absorber without intermediate flashing or separation.

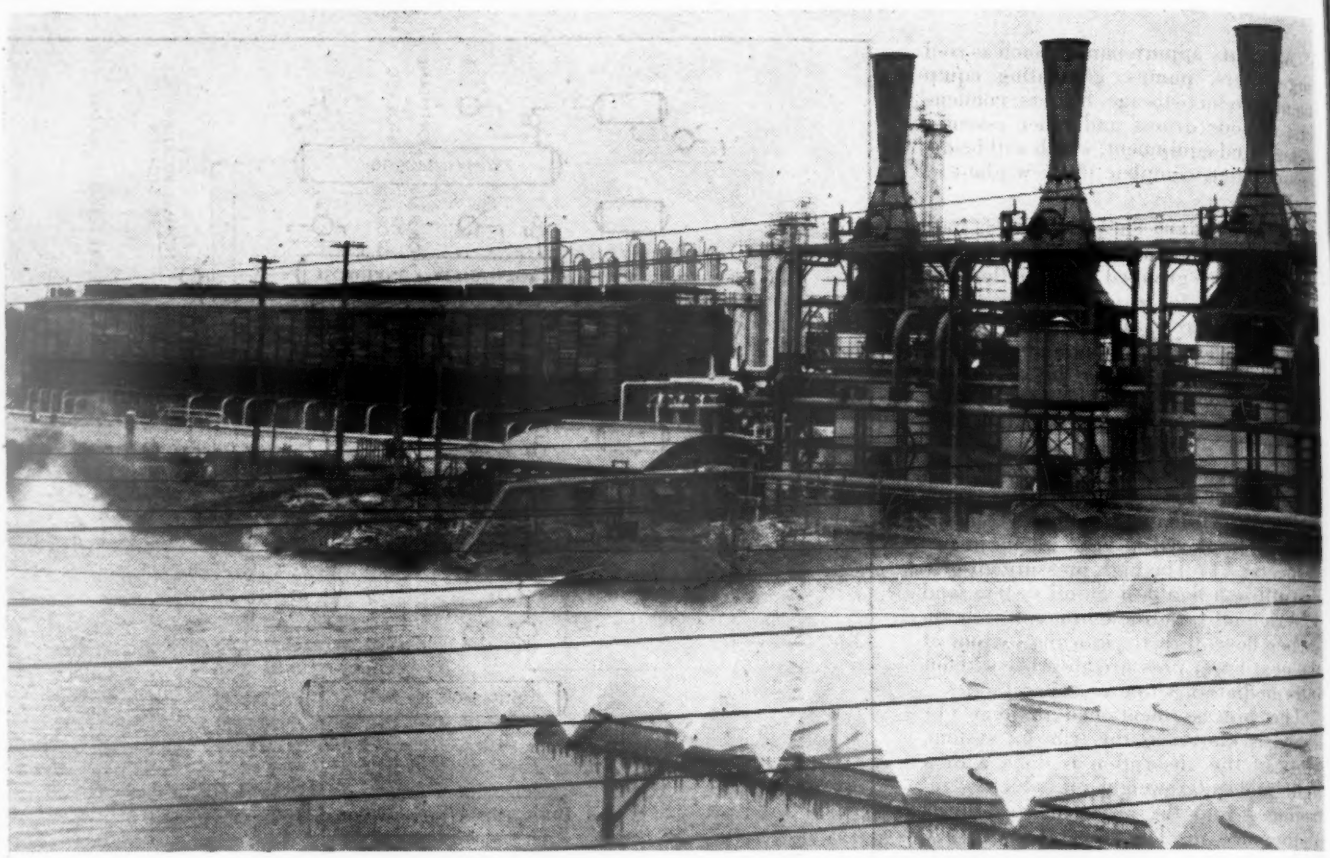
The process mentioned in item (1) above is known as the trim oil system. Most of the absorption is done with a light molecular weight oil, which is introduced into the absorbers two-thirds of the way up. The trim oil is a heavy high molecular weight oil that has a high initial boiling point, approximately 450-500°F. The heavy oil is introduced into the top of the absorbers and serves to absorb and thus save the light lean oil that otherwise would retrograde into the gas. Thus, it is necessary to circulate a smaller volume of lean oil. Additionally, the lean oil used is considerably easier to prepare.

● **Plant flow.** Two central gathering stations are provided into which the gas and oil mixture is brought for separation. One station serves the wells that have a low gas-oil ratio, the other the wells of higher gas-oil ratio. At these stations the gas and oil are separated in batteries of separators that operate at pressures corresponding to the operating pressures of the plant absorbers. Gas is sent directly from the separators to the absorbers. The oil is metered and pumped to six 5000-bbl. working tanks from where it is sent to the refinery. Once a month these liquid meters are calibrated by running the oil into fifteen 500-bbl. tanks instead of into the working tanks, where it is measured as a check against the accuracy of the meters. The test covers a period of 24 to 48 hours.

Flow through the absorbers is as previously described. From the absorber battery the rich oil passes to rich oil heaters, which are two in number and have a 120,000,000 B.t.u. per hour pickup.

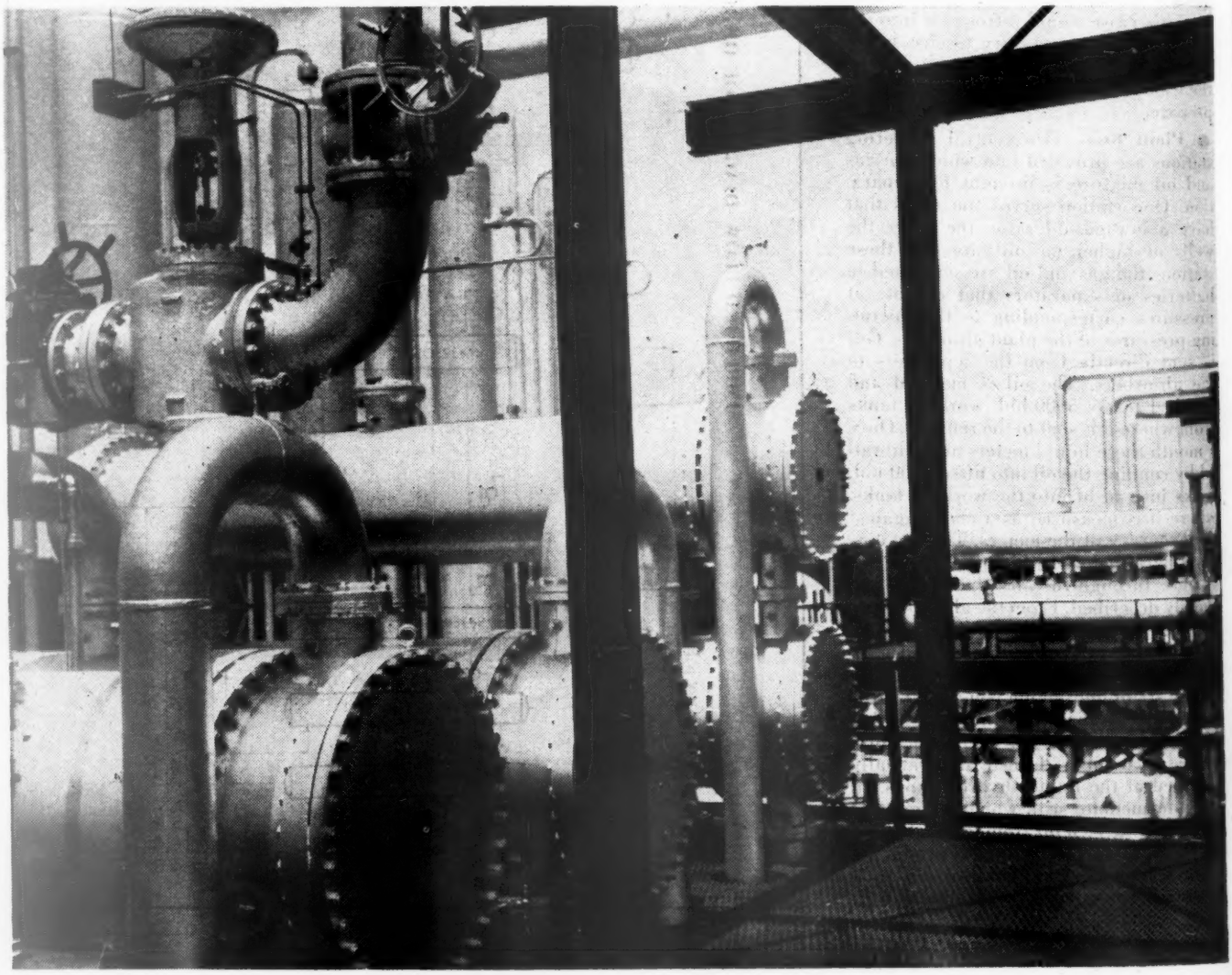
The stripping section consists of three stills. In the high-pressure still, which operates at 185-200 lb. per sq. in., preheated rich oil is flashed and partially stripped of the lighter hydrocarbons. In the intermediate still, which operates at 50-60 lb., the rich oil from the high-pressure still is further stripped, producing a light molecular weight lean oil as a bottom product and raw gasoline as over-

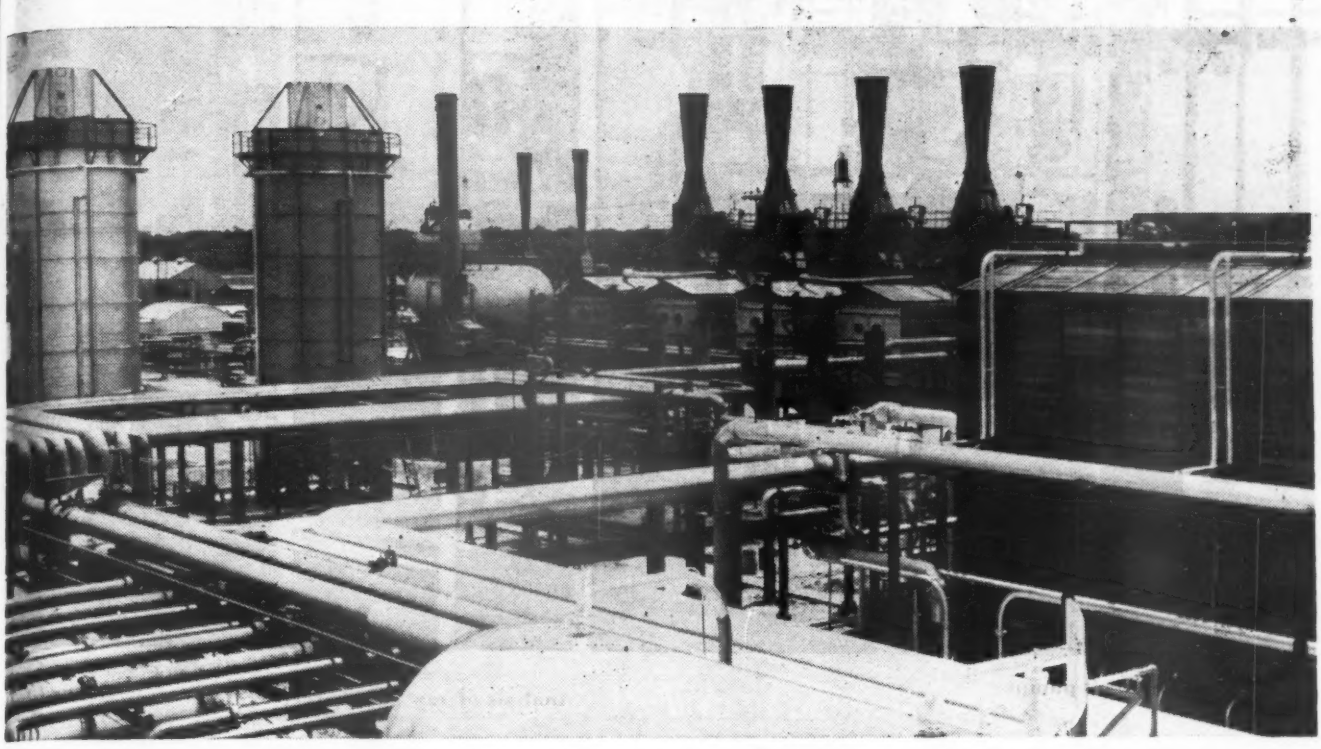




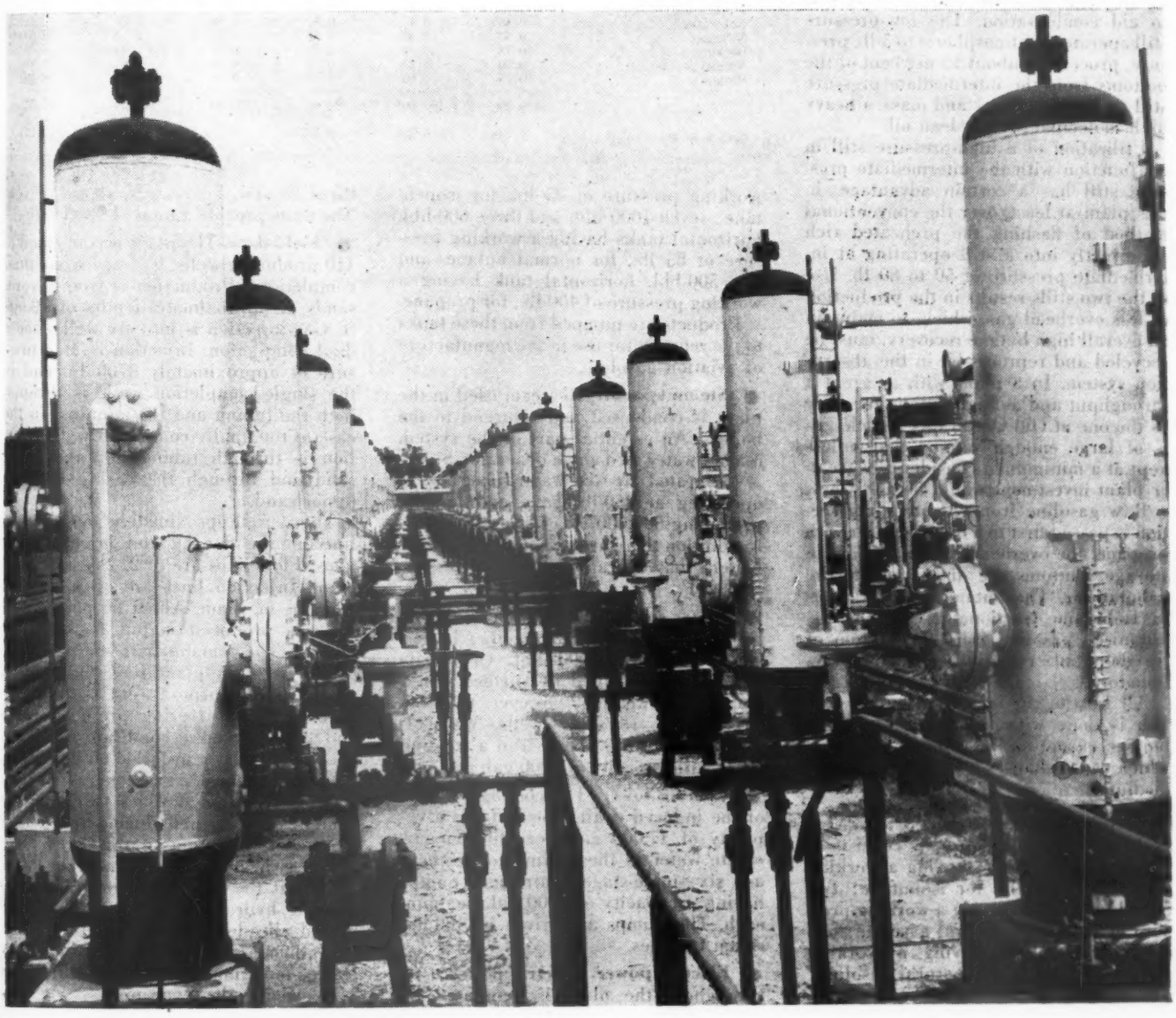
**Water tube boilers operate at 250-lb. pressure (right). Induced-draft cooling tower at left.**

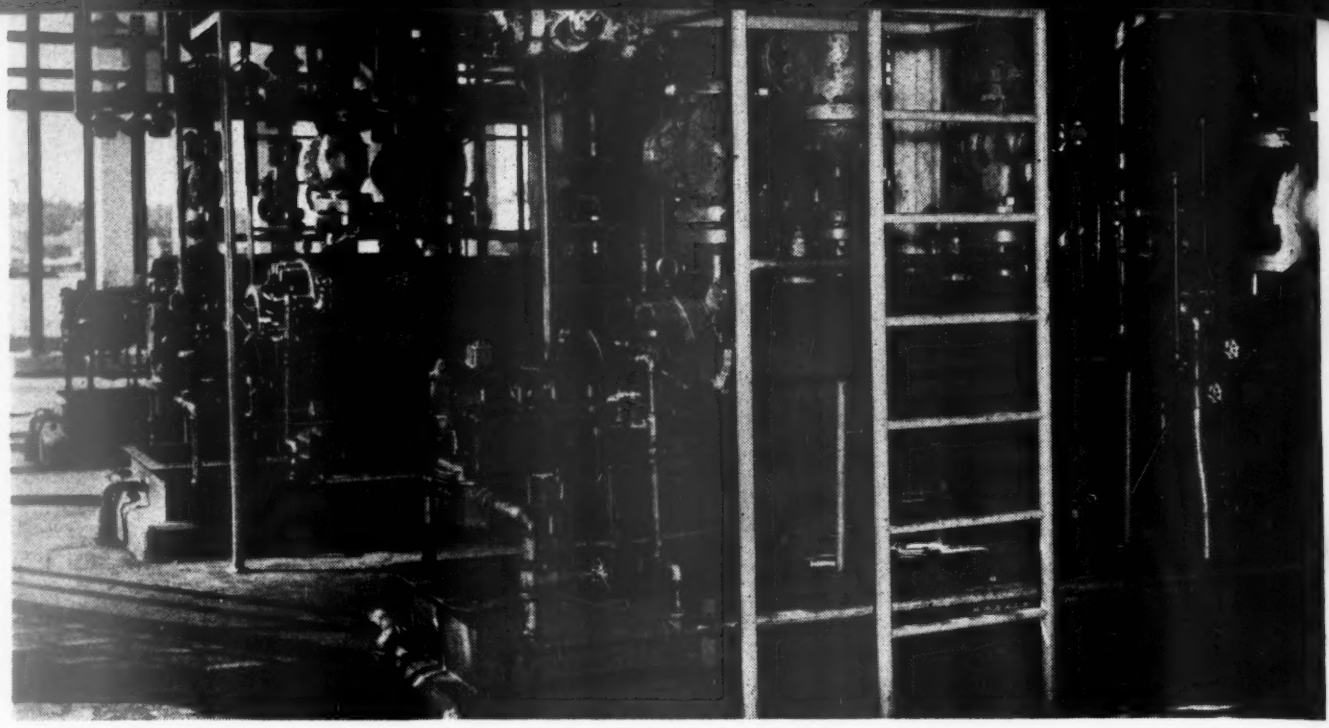
**Still overhead condensers on a platform above reflux drums that are on a platform above pumphouse.**





General view showing boilers, heaters, and part of cooling tower. *Below*—Oil and gas separators.





**Absorption oil pumps**

head. The raw gasoline is pumped into the overhead from the high-pressure still to aid condensation. The low-pressure still operates at atmospheric to 5-lb. pressure, processing about 15 per cent of the bottoms from the intermediate pressure still to strip it further and make a heavy high molecular weight lean oil.

Utilization of a high-pressure still in conjunction with the intermediate pressure still has a certain advantage, in this plant at least, over the conventional method of flashing the preheated rich oil directly into a still operating at intermediate pressure of 50 to 80 lb. Use of the two stills results in the production of less overhead gas, which, to maintain an overall high butane recovery, must be recycled and reprocessed in the absorption system. In a plant with as great a throughput and as high butane recovery as the one at Old Ocean this recycle gas is of large enough volume that unless kept at a minimum a considerably greater plant investment would be necessary.

Raw gasoline from the stripping section is passed first to a depropanizer with propane, the overhead product, going to storage. Bottoms are discharged to the debutanizer. The butane overhead goes to isobutane fractionator and the debutanized gasoline from the bottom of the debutanizer to the isopentane fractionator.

All heating in the fractionating system is done with lean oil through reboilers, except on the isobutane column, which uses exhaust steam as the heating medium.

● **Product storage.** Product storage for both the old and new plants consists of two 5000-bbl. spheres having a working pressure of 85 lb., for isobutane; two 5000-bbl. spheres having a working pressure of 15 lb., for natural gasoline; one 10,000-bbl. sphere having a working pressure of 15 lb., for natural gasoline; ten 600-bbl. horizontal tanks having a working pressure of 25 lb., for isopentane; seven 1000 bbl. and three 600-bbl. horizontal tanks having a working pressure of 85 lb., for normal butane, and one 500-bbl. horizontal tank having a working pressure of 400 lb., for propane.

Products are pumped from these tanks to the refinery for use in the manufacture of aviation gasoline.

**Analysis of raw gas charge.**

| Pressure (lb. per sq. in. ga.) | 2250 | 1250 | 500 | 150 | 50 | Vac. |
|---|---|---|---|---|---|---|
| Analysis (mol per cent): | | | | | | |
| Methane | 90.83 | 91.27 | 91.81 | 89.33 | 68.51 | 56.43 |
| Ethane | 5.04 | 4.96 | 4.50 | 5.52 | 13.73 | 8.90 |
| Propane | 1.90 | 1.80 | 1.86 | 2.46 | 10.20 | 15.35 |
| Isobutane | 0.50 | 0.43 | 0.50 | 0.59 | 2.21 | 6.48 |
| N-butane | 0.57 | 0.57 | 0.52 | 0.60 | 2.52 | 5.60 |
| Isopentane | 0.18 | 0.18 | 0.21 | 0.36 | 1.00 | 3.76 |
| Normal pentane | 0.20 | 0.19 | 0.21 | 0.23 | 0.63 | 1.98 |
| Hexane plus | 0.78 | 0.60 | 0.39 | 0.91 | 1.20 | 1.50 |
| | 100.02 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Sp. gra. of hexane plus | 0.739 | 0.739 | 0.739 | 0.739 | 0.739 | 0.739 |

● **Steam system.** All steam used in the plant is condensed and returned to the boilers. An essential part of the system is a hot water feed and a deaerator. Steam is generated by six water-tube boilers operating at 250-lb. gage and 550°F., producing 500,000 lb. of steam an hour. In addition there are five oil-country type boilers that operate at 250-lb. pressure at 600°F.

● **Water supply.** Water supply is from two artificial lakes that together have a capacity of 4,000,000 bbl. Ordinarily these lakes are filled by surface water. During dry weather, however, they are supplied by 18 water wells. Water is treated with lime soda ash in a treating plant with capacity of 3000 gal. per min.

● **Cooling tower.** The cooling tower is of the induced draft type and has a capacity of 17,000 gal. per min. To circulate water in the cooling tower there are six single-stage centrifugal pumps having a capacity of 3000 gal. per min. each. The pumps are driven by 160-hp. steam turbines.

● **Electric power.** Electric power used throughout the plant is generated by three 250-kw. generators, steam driven. The units provide a total of 2300 volts.

● **Field data.** The plant is connected to 110 producing wells, 9 of which are dual completions. Production is from several sands at approximate depths of 10,000 ft. Gas injection is into six wells, one a dual completion. Injection is at a pressure of approximately 3700 lb. and in the single completion wells is through both the tubing and the annulus. In the case of the dually completed well, injection is through tubing into the lower sand and through the casing into the upper sand.

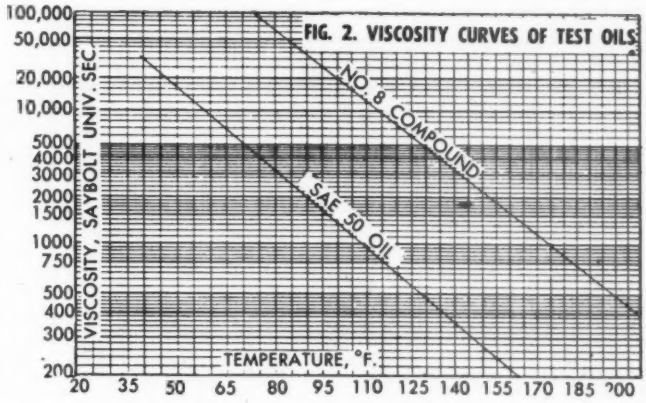
There are approximately 150 miles of lines in the flowing and injection systems. Flow lines are of 2, 2½, and 3 in. diam. Injection lines are of 3, 5 9/16, and 8⅝ in. diam. About 60 per cent of the gas produced is put back in the ground. The remainder is sold commercially, used for plant fuel, for drilling rigs, heating purposes, etc.

In winter a freezing problem exists and to overcome this condition automatic heaters have been installed on flow lines. Some of the lines are as long as 1800 ft. and on these longer lines two or three heaters are required during the colder months. In addition to this preventive measure, heat exchangers have been installed at the two separator stations to prevent hydrate formation. These are placed ahead of the separators.

Wellhead pressures are reduced by chokes to various pressures at which gas is received by the separators. ★★★

# *Effect of* VISCOSITY ON ROTARY PUMP PERFORMANCE

**VIRGIL A. BRUNSON,** *Development Engineer,*
Blackmer Pump Company




**EXCLUSIVE** WHEN selecting a rotary pump for a specific installation, it is important that there be available complete data on the liquid to be handled, operating conditions, and pumping rate. From these data can be determined the size and style of pump, the speed, pump materials, special clearances, type of packing, and the size of motor required.

Of particular importance is the viscosity of the liquid to be pumped. To determine accurately the effect of viscosity on pump performance, tests were run on the swinging vane type of pump at various speeds and on different viscosities. Several pumps rated at 90 gal. per min. were run under each set of conditions and the average results used. Fig. 1 shows the operating principle of the pumps tested.

Pumps were driven through a single-reduction gearbox by a calibrated electric motor. Prior to taking data each pump was "run in" long enough to eliminate any possible binding, bearing heating, or excessive packing friction, and to warm the oil in the gearbox.

In order to obtain complete horsepower data on all viscosities between 500 SSU and 50,000 SSU, tests were run on two separate oils, SAE 50 and a compounded oil of high viscosity. The viscosity-temperature curves of these oils are shown in Fig. 2. By changing temperatures from 70° to 135° on each oil, a complete coverage of viscosities was made.

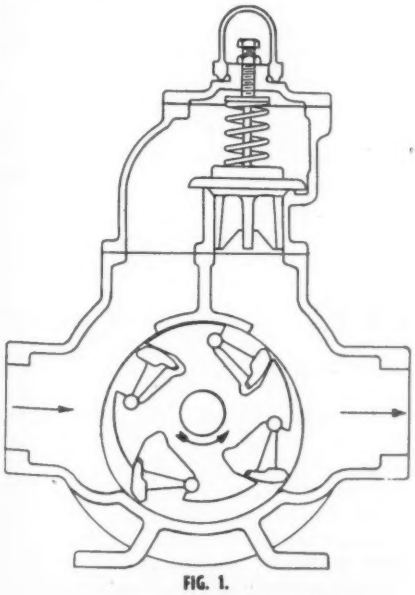


FIG. 1.
SWINGING VANE TYPE ROTARY PUMP WITH RELIEF VALVE.

Fig. 3 is a typical performance curve showing the horsepower consumed for each viscosity at which the pump was run on SAE 50 oil. The pump delivery in gallons per minute was affected very little by viscosity on this particular test. Similar curves were run on the compounded oil. Families of curves were also made on each oil at three slower speeds.

The horsepowers plotted include the power required to drive the pump and gearbox. The majority of rotary pumps require a gear reduction between the pump and motor—and it was considered desirable to include the total power required rather than just the power necessary to drive the pump.

The SAE 50 oil was a Mid-Continent oil refined by conventional methods with no additives. The heavier oil was a black compounded oil used for extreme temperature and pressure applications such as in steel mill rolls.

Fig. 4 is a diagrammatic breakdown of the brake horsepower. Part A is frictional horsepower at no load. Part B is the increase in frictional horsepower caused by increasing loads on gears, bearings, and packing with increase in pumping pressure. Part C is hydraulic horsepower.

The frictional horsepower, part A, for all pump speeds and viscosities was plotted on logarithmic paper, Fig. 5. All curves are straight lines with the same slope. The curves for SAE 50 oil are nearly in line with those for the compounded oil. It is believed that the deviation is caused by different lubricating qualities of the two oils when their viscosities are the same.

The tests on No. 8 compound at 410 was omitted because the horsepower exceeded the capacity of the single reduction gearbox used on the other tests.

From these curves it was determined that the friction horsepower at no load was proportional to a power of the SSU value. From the slope of the curves it was determined that this power was 2.2.

It was found that the friction horsepower varied as a power of the speed. This power was determined to be 1.62.

With these laws of friction established, a formula for determining the brake horsepower at any speed and viscosity can be drawn.

$$HP_B = HP_W + HP_F$$

$HP_B$ = brake horsepower,
$HP_W$ = water or hydraulic hp.,
$HP_F$ = frictional horsepower.

$$HP_W = \frac{GPM \times Hd_w}{3960}$$

GPM = gallons per minute delivered,
$Hd_w$ = total head in feet of water.

$$HP_F = \left[\sqrt[2.2]{\frac{SSU}{1000}} \times 1.28\right] \times \left[\frac{RPM}{410}\right]^{1.62} + \left[\frac{Hd_w}{250} \times 0.6\right]$$

The value 1.28 is the friction horsepower at no load at 410 r.p.m. at 1000 SSU. The 0.6 factor is the part B. Fig. 4 or the increase in friction horsepower at 250 ft. of head, which is constant for all speeds and viscosities.

The brake horsepower for any speed and any viscosity would then be:

$$HP_B = \frac{GPM \times Hd_w}{3960} + \left[\sqrt[2.2]{\frac{SSU}{1000}} \times 1.28\right] \times \left[\frac{RPM}{410}\right]^{1.62} + \left[\frac{Hd_w}{250} \times 0.6\right]$$

A general formula for any size pump of this type would be:

$$HP_B = \frac{GPM \times Hd_w}{3960} + \left[\sqrt[K_1]{\frac{SSU}{1000}} \times K_2\right] \times \left[\frac{RPM}{RPM}\right]^{K_3} + \left[\frac{Hd_w}{250} \times K_4\right]$$

The four constants can be determined for any size of pump by getting accurate horsepower tests at two speeds and at two viscosities.

This formula provides an accurate method of obtaining complete horsepower data at all speeds and viscosities on a new model of pump without actually testing it under all conditions.

Some oils have a variable viscosity at constant temperature. In selecting suitable test oils for these experiments it was discovered that a steam refined cylinder stock oil under consideration had a different SSU value at room temperature whenever it was tested. Samples were sent to several commercial and major oil company laboratories. All tests were different and varied more than 100 per cent in SSU value at the same test temperature. After some research it was discovered that the viscosity varied with agitation. After standing stagnant for

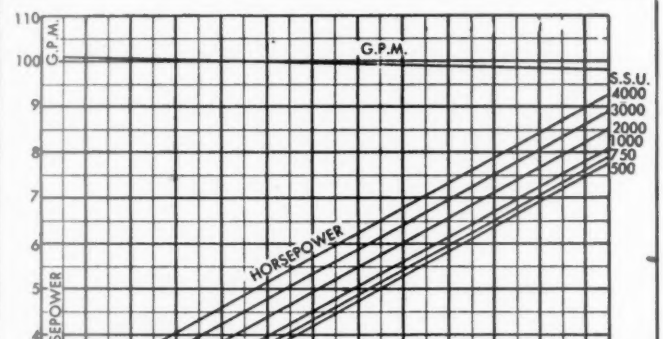



FIG. 3. TYPICAL PERFORMANCE CURVES. THESE ARE AT 410 r.p.m. ON SAE 50 OIL.

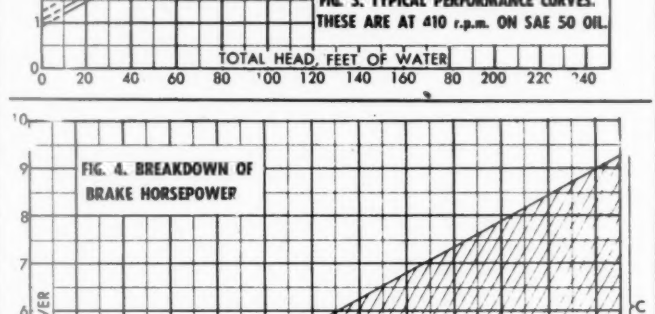



FIG. 4. BREAKDOWN OF BRAKE HORSEPOWER

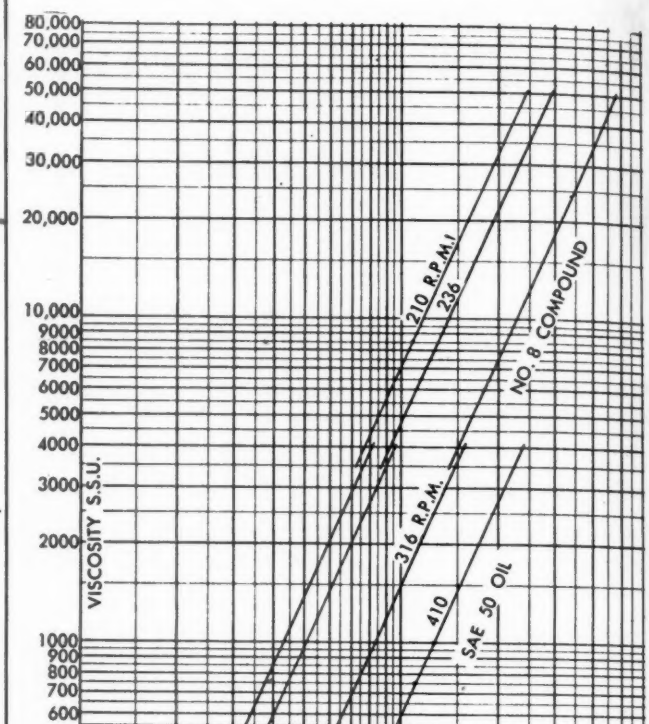



FIG. 5. VISCOSITY-FRICTION HP CURVES

several days, the viscosity would be high. The same oil stirred vigorously would have less than half the SSU value. The oils that were selected for these tests had stable viscosities.

At slower speeds there was less centrifugal force on the buckets, and at very high viscosities they did not swing out rapidly enough. This caused a drop in volumetric efficiency. In these cases springs were used behind the buckets.

At viscosities from about 50,000 to 100,000 SSU some cavitation occurs at the higher pump speeds. This is incomplete filling of the pump caused by the pump running faster than the liquid can flow. Therefore, it is usually recommended that a pump be slowed down for handling liquids of high viscosities.

Because the horsepower varies as the 1.62 power of the speed, often a smaller motor can be used by using a larger pump slowed down. A worthwhile saving in power costs can thus be made.

Some extremely viscous liquids such as pitch, have such high adhesive qualities that they form a coating on the outside of the rotor. Because of the close clearance between the rotor and casing at the tangent point, coating is wiped or sheared off each revolution. This can cause high horsepower consumption. In these cases the rotor is made a few thousandths of an inch undersize.

From these data the importance of viscosity readily can be seen. Viscosity of the liquid to be pumped should be included with every pump specification so the pump manufacturer can supply the proper pump with accurate internal clearance and with proper size motor and gear reduction. ★★★

P 422.334

# GOOD BOILER FEED REGULATOR SAVES FUEL

By W. F. Schaphorst

THIS writer has been asked a number of times, "Just how much fuel should a good boiler feedwater regulator save?"

I have seen reports by users in which it was shown that the savings range all the way from 2 to 8 per cent in fuel costs. The average is 4 per cent, and that is the figure that I would advise anyone to use who is figuring on installing a first class boiler feed regulator.

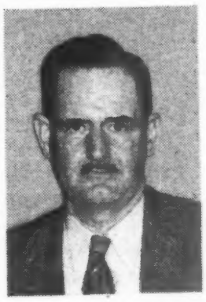
A high quality boiler feed regulator does not cost much compared with the savings it makes in a year's time. Such regulators are almost invariably a good investment. The ideal boiler feed regulator stabilizes the boiler water level within the safe limits that have been carefully set. It temporarily increases the feed rate at every sudden drop in the load and stores up surplus furnace heat in the form of heated water. Then when the peak load comes on, it momentarily cuts down the feedwater input and uses the "stored heat" over the peak without permitting a heavy influx of cold water.

In addition, there are other important savings to bear in mind, such as: Less wear and tear on heaters, economizers, feedwater pumps, and pipe lines, and much of the boiler operator's time is released for other important work that cannot be performed automatically. A high grade boiler feed regulator is entirely automatic and dependable. ★★★

# REFINERY MAINTENANCE ENGINEERING

By **H. J. WRIGHT**, Socony-Vacuum Oil Company, Inc.

**EXCLUSIVE** THE production lines in a modern oil refinery take no holidays. A "day off" means just that much loss of production and idle non-productive investment. A shutdown of a single unit often represents an idle investment of several millions of dollars. The interest alone on a $3,000,000 investment is $500 a day, to which must be added loss of profit, continuing depreciation, approaching obsolescence, etc. The cause of the shutdown itself is frequently the failure or breakdown of an integral part representing a very small comparative investment, thus relatively small but influential out of all proportion to itself. To put the idle unit back on stream as quickly as possible becomes an emergency of first magnitude, justifying the maximum use of every facility to accomplish the job in the least possible time.



H. J. Wright

There are two kinds of speed in taking care of any job. One is frantic speed —the result of insufficient planning; the other is the speed and smoothness that come from knowing how and from proper preparation. The first is costly, the second economical. Although fortitude is a great help when in distress, a pound of thoughtful preparation is much more successful than depending on a ton of good luck.

Most everyone is familiar with the necessary equipment, personnel, foremanship, work order system, and operation of modern mechanical shops and trades, all of which of course should be adequate. Also, the procedure on how to do most repair jobs is uniformly established, although it is all subject to progressive improvements from time to time.

After a specific maintenance job has been thoroughly established in the repair shops, or placed in the hands of capable and efficient mechanical department field forces, it becomes routine and is usually fairly well taken care of if suitable mechanics and foremen are available. Preceding the actual mechanical work of doing a job, it first must be analyzed to determine what caused the trouble and what measures can be taken to prevent a recurrence. Determine first, in as much detail as possible, just what is to be done, what materials, working equipment, and mechanics are required, when the job must be done, when is the best time to do it, and what other jobs, if any, does it take preference over.

After the job has thus been analyzed, efficient arrangements can be made for the execution of the work by issuing very specific and well understood work orders and advice to the mechanical trades. Thus informed, the mechanical department can make the most efficient arrangements to do the job. The maintenance engineer may frequently find it advisable to consult the mechanical trades foremen in making such analysis.

We have all observed cases where a job is undertaken with very little investigation and much guesswork; where the workmen on arriving at the job cannot find adequate instructions, where needed tools and materials are missing.

Maintenance should not be the most unpredictable element in the industry. There are, of course, unexpected breakdowns that will occur but by careful routine inspection and analysis, coming events may be calculated to a surprisingly close degree. When forewarned there is not much excuse for being unprepared to meet the situation with prompt and efficient action.

Breakdowns are not cyclic, like the coming and going of the Iris at regular intervals. They can be forecast remarkably close if enough evidence is obtained in advance; only it is necessary to get plenty of evidence. Such evidence includes careful watch over and inspection of equipment during the operating periods, calculating the remaining life and probable date when shutdowns for maintenance should be made on a basis of measured wear or corrosion over definite time periods, plus many other observable symptoms of mechanical weaknesses and impending breakdowns or wearouts.

The fouling of 4 or 5 buckets of a very large elevator was detected before serious trouble occurred by first noting sharp but brief rises in an ammeter chart at intervals corresponding exactly to one complete circuit of the elevator chain.

***Maintenance is important—the shutdown of a single unit often represents an idle investment of several million dollars.***

● **Correct lubrication.** The necessity for correct lubrication is often taken too lightly, and with costly consequences. Exact lubrication specifications for each piece of equipment should be provided by the lubrication engineer and these should be followed religiously. The last place to neglect lubrication would seem to be in an oil refinery, yet when main bearings of a new and costly machine were burned out some years ago for no apparent reason, the machine manufacturer's service engineer was promptly called in with considerably less than "warm greetings."

Even he could find no cause for the trouble (there was plenty of oil in the proper places) until he put his hands in the crankcase in search of abrasives and immediately realized that the oil was far different from that specified on the lubrication instruction plate conspicuously posted on the machine. The attendant, on being questioned about the source of the lubricating oil used, pointed to a nearby large oil storage tank. The tank contained an unblended oil stock. It was oil, very conveniently at hand, but far from the correct lubricant. This is a glaring case of inattention to important maintenance details and lack of engineering checkup.

Engineered maintenance is closely allied with the original research and engineering designs on which the production units were built, and engineering follow up of mechanical performance is valuable and important. Experience also has shown the opposite practice, where expensive and essential equipment was purchased on carefully written performance specifications and, in actual service, insufficient engineering checkup failed to show that the equipment did not continue to give expected performance. This may be due to insufficient maintenance of the equipment or the equipment may never have performed the purchase specification. Also, some inherent weakness or deficiency may be detected and remedied.

● **Repair records valuable.** A close checkup on well-kept repair records can contribute to better selection of equipment on the next installation. When equipment is down for repairs a careful comparison should be made of the original performance specification and actual performance records, and a real attempt made during repairs to do whatever is necessary to return the unit to service at maximum efficiency.

Preventive maintenance can be practiced in the same manner by careful systematic inspections and checkups.

*H. J. Wright is chief engineer, Paulsboro, New Jersey, refinery, Socony-Vacuum Oil Company, Inc. He joined the company in 1924 in charge of refinery engineering and the mechanical department. He previously was with the Barrett Company, chemical division, Philadelphia, Pennsylvania, as plant engineer. He obtained his engineering education at Armour Institute of Technology and University of Chicago.

Supervision of the maintenance working crews is extremely important today. There is little danger of having too much supervision; if it is the proper quality of supervision it is more likely to be a good investment than an added expense. With the labor situation what it is and the increasing technicalities of present day mechanical equipment and manufacturing processes, maintenance mechanics require more guidance, without which the production per man-hour is below par and the job is likely to be improperly done.

We can plan carefully our maintenance work for the next day and for days and weeks ahead on the basis of the work we know of, but after anticipating jobs and planning strategy the maintenance forces, like an army at the front, are rapidly revising their strategy or daily work program to meet emergencies that have developed during the night, and that develop hourly throughout the day. A critical breakdown will require instant attention and at the sacrifice of some less critical job or jobs, thus bringing up the matter of quickly determined priorities and rapidly shifting of maintenance men. This causes a loss of man-hour maintenance production in leaving one job unfinished to move to the new emergency and upsetting a planned daily work schedule. This is a condition to be expected and must be accepted promptly and willingly.

This can all be taken care of by one maintenance engineer, the master mechanic or head repair man, if he does not have too much territory to cover. In large plants it becomes essential to subdivide the maintenance engineering supervision into areas or zones of a size to which one engineer can give proper attention. A large oil refinery covers great areas and has many production units, each of considerable magnitude and complexity. We may designate the engineer in charge as mechanical supervisor, maintenance engineer, or any designation set by local management or organization. In the writer's case the plant maintenance subdivisions were established in 1934 and are designated as zones. The engineer in charge of each zone is the zone engineer, whose prime responsibility is maintaining mechanical security in his zone.

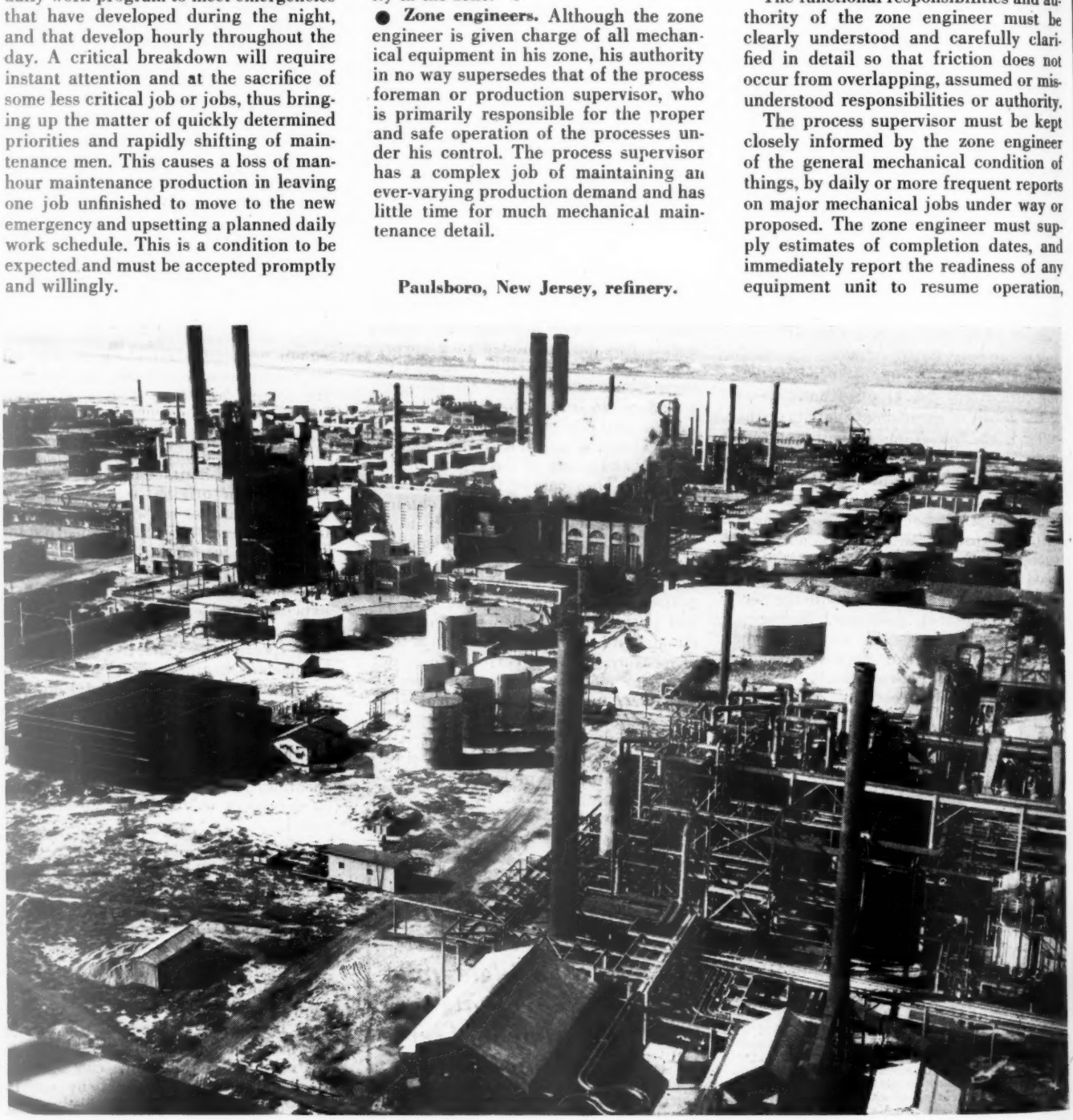
● **Zone engineers.** Although the zone engineer is given charge of all mechanical equipment in his zone, his authority in no way supersedes that of the process foreman or production supervisor, who is primarily responsible for the proper and safe operation of the processes under his control. The process supervisor has a complex job of maintaining an ever-varying production demand and has little time for much mechanical maintenance detail.

The zone engineer's first duty is to collaborate closely with the process supervisor. It is extremely important that this feature of working together on all major questions be maintained with the highest possible effectiveness, thus, the zone engineer is functionally responsible to the process supervisor in maintaining the production units in good mechanical condition, so that proper quantities, qualities, and efficiencies of production are maintained. This, of course, is what the entire plant organization is most concerned about.

The zone engineer is then functionally responsible to the chief engineer's office in providing an engineering and mechanical supervision and analysis service in the field in accordance with the best engineering and standardized practices.

The functional responsibilities and authority of the zone engineer must be clearly understood and carefully clarified in detail so that friction does not occur from overlapping, assumed or misunderstood responsibilities or authority.

The process supervisor must be kept closely informed by the zone engineer of the general mechanical condition of things, by daily or more frequent reports on major mechanical jobs under way or proposed. The zone engineer must supply estimates of completion dates, and immediately report the readiness of any equipment unit to resume operation,



**Paulsboro, New Jersey, refinery.**

especially when such equipment is needed to improve general production.

The zone engineer, in turn, should receive prompt and formal reports from the mechanical trade foreman or mechanic of their completion of each important job, so that there is no time lost in returning the idle unit to operation as soon as the repair job has been completed.

After a complete production unit, or major portion thereof, has been shut down for general repairs, metal inspection or cleaning that has involved extensive disconnecting and internal examination of equipment, a careful final checkup has to be made to see that all details are completed and in readiness to resume production operations.

The process supervisor should not order a resumption of operations until he has received a written memorandum from the zone engineer stating that all mechanical conditions are in readiness.

The zone engineer before issuing his readiness report must take careful steps to see that nothing has been missed. He should make a careful personal inspection of general conditions, and more specifically call on the foreman or leader of each mechanical trade to issue a written memo, or at least a verbal report that all work in his respective trade is completed.

The zone engineer must possess special qualifications for the job. He should have a good engineering education, augmented by considerable practical experience in the design, installation, and operation of mechanical equipment. He should have an inventive mind, be a quick and keen analyst, and be right on the firing line. He must feel the fascination of being a vital and important part of the production process. When we are doing something we like we usually do it well. The job is not an easy one and requires much physical activity in covering a zone and keeping up with the multitude of jobs that require attention. A good zone engineer should not give advice by the pound while he is unable to take an ounce or so himself. When in search of the truth and fact, he should have a receptive mind, plus a general attitude of social mindedness that actually attracts suggestions and then considers all possibilities, plus a Sherlock Holmes knack for ferreting out the truth. He doesn't always "hold the bag" without getting "some company" by inviting the opinion of the practical foreman or mechanic who may not know about all the technical side, but does have a wealth of practical experience to draw upon. Differences of opinion is what makes good horse racing. It also helps in arriving at good decisions when by friendly open-minded discussions important problems can be weighed from all angles. Programs of maintenance procedure should then be clearly articulated by the zone engineer and "popularly" understood by the mechanics rather than accepted with misgivings so that the zone engineer will not be a goat designate.

There is a close tie-in between zone engineers and the mechanical department trades, especiallv with the master mechanic's office, through which, and by regularly established foremen's meetings, the status of maintenance work and requirements is discussed, working schedules and allocation of mechanics are planned.

The zone engineer is in charge of all maintenance work in his zone. He also supervises new construction work in the zone, except such large construction projects as require the entire time of a project engineer. He analyzes the need for all repairs and reconditioning of equipment, carefully schedules and specifies needed repairs, mechanical adjustments and alterations, issues repair work orders to mechanical trades, supervises the work in progress, ascertains priorities for the work scheduling, conducts mechanical efficiency tests, analyzes causes of mechanical failures so that proper corrective measures can be taken, etc. He must be given freedom of action in analyzing a situation on the spot and deciding quickly on appropriate procedure and methods of adjustment.

Carried directly on the process department payroll in each zone is a small force of mechanics known as departmental repairmen. There should be just the right number of such repairmen as can be kept constantly busy on the smaller routine maintenance jobs. The additional mechanics needed for the larger jobs are obtained through the central mechanical department shops and are covered by separate specific work orders for each job.

● **Zone engineer setup.** Our local refinery is divided into five zones, each in charge of a separate zone engineer.

Each zone office is set up on a uniform standard basis of office files and records. Sets of equipment record cards are at hand giving full description of each piece of mechanical equipment within the zone, and on these records of repairs are also kept. Inspections, tests, etc., are also filed uniformly. Copies of detailed drawings and specifications of mechanical equipment within the zone are also on file for convenient reference without having to go to central engineering department files for the average routine job. Zone offices are also equipped with a drafting board, etc., as zone engineers frequently find it desirable to prepare quick sketches and simple drawings as an aid to field instructions and for record purposes.

Repair and maintenance work in a large oil refinery involving several hundred mechanics is really a difficult job, and much credit is due to the supervisors, foremen, and organization that succeed in doing it well. In a mechanical production line, if it is manufacturing airplanes or air compressors, the production line when once designed becomes quite permanent and automatic in daily procedure; materials flow automatically to their proper places in the assembly line, and the daily duties of the individual employes become more or less routine. Not so for a repair and maintenance organization. Their production lines have to be redesigned daily, often hourly. ★★★

## German records to be available

Technical information collected from secret records of the German oil industry by the Petroleum Administration for War will be made available immediately, Deputy Petroleum Administrator Ralph K. Davies announces.

In order to capitalize on German technical developments, PAW will release through the Technical Advisory Committee of the Petroleum Industry War Council microfilms of documents captured in German refineries and laboratories, he said.

Davies explained that the microfilms of refinery records and experimental laboratory data were gathered by a mission of technological experts sent to Europe under PAW auspices last year.

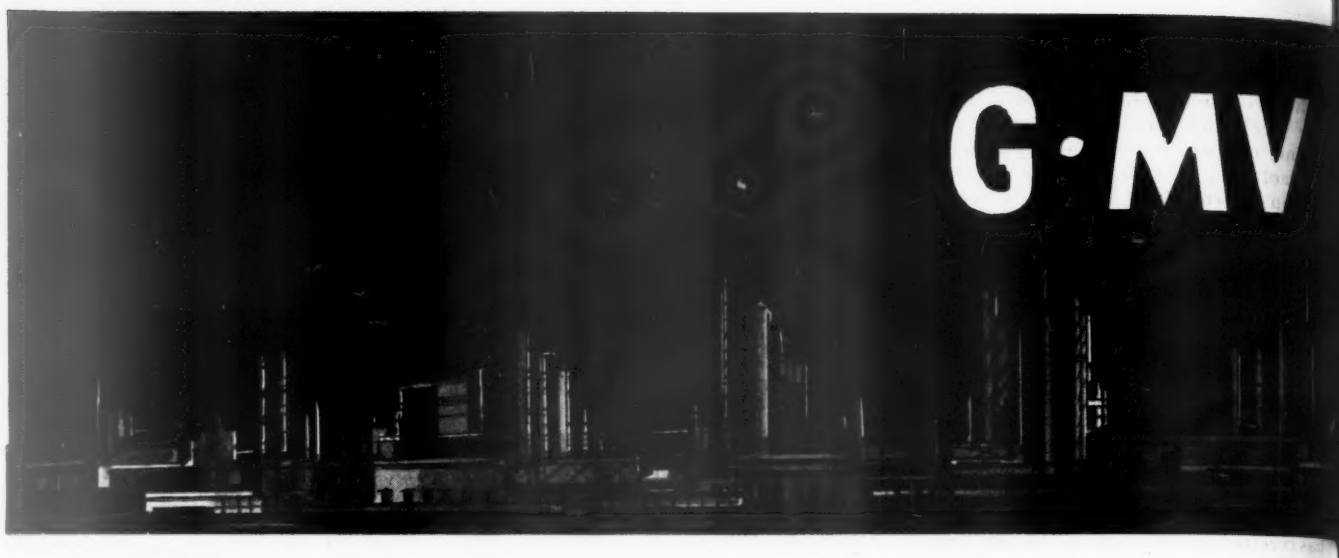
The records are still classified as restricted material and, cannot therefore be distributed except on a restricted basis.

It is PAW's desire, Davies pointed out, to make these technical data freely available to everyone interested as a matter of public information, subject only to such restrictions as are imposed by the military or other responsible authorities of government. It is anticipated that in the near future the present restrictions will be relaxed.

"Due to the vast quantity of records collected and the limited staff of the PAW available for this type of work," Davies said, "the aid of the Technical Advisory Committee has been enlisted to speed up the process of translating and evaluating the records.

"As additional microfilm records are received, they will be indexed by PAW and duplicates will then be turned over to the Technical Advisory Committee for translation and evaluation. The first indexes already have been sent to the committee, and others will be as they arrive by air from time to time."

Davies announced that copies of the PAW index of all microfilms received will be distributed as restricted material to refineries and to other branches of the oil industry at the same time that the duplicates are sent to the Technical Advisory Committee. From the index, copies of the microfilms may be ordered on payment of a nominal charge covering the cost of processing.




December marked the beginning of the second half year of 100 octane gasoline production for Continental Oil Company's new Oklahoma plant where 2,000 G-MV compressor horsepower serve the Thermofor catalytic cracking units in this complete and very modern plant.

Cooper-Bessemer's efficient G-MV's are found holding steadfastly to production schedules in every kind of compressor service. But here are just four of the important reasons why they are so practical and effective for the production of aviation gasoline and for refinery service in general:

**1. VERSATILITY** . . . G-MV compressor cylinders are available in a wide variety of types and sizes for compressing air or any gas, and permitting any combination of volumes and pressures within the engine's rating. Every crankthrow is available for driving a compressor cylinder, if desired, affording extreme flexibility and latitude in application.

**2. COMPACTNESS** . . . In the G-MV, 2-cycle operation is combined with V-type design to provide an unusually low space-to-horsepower ratio despite conservative speed. Built in 400, 600, 800 and 1000 hp sizes, unit length averages only 4' 2" for each 200 horsepower — a decided advantage particularly in plants requiring a high total horsepower.

**3. RESPONSIVENESS** . . . G-MV's are noted for their smooth operation and sensitive response to control — the result of Cooper-Bessemer's precise "Silent-Scot" fuel injection, "Streamlined" scavenging and correctly selected ignition, combined with inherent freedom from vibration and advanced "uniplane" design. Thus the most exacting demands can be met ideally and economically.

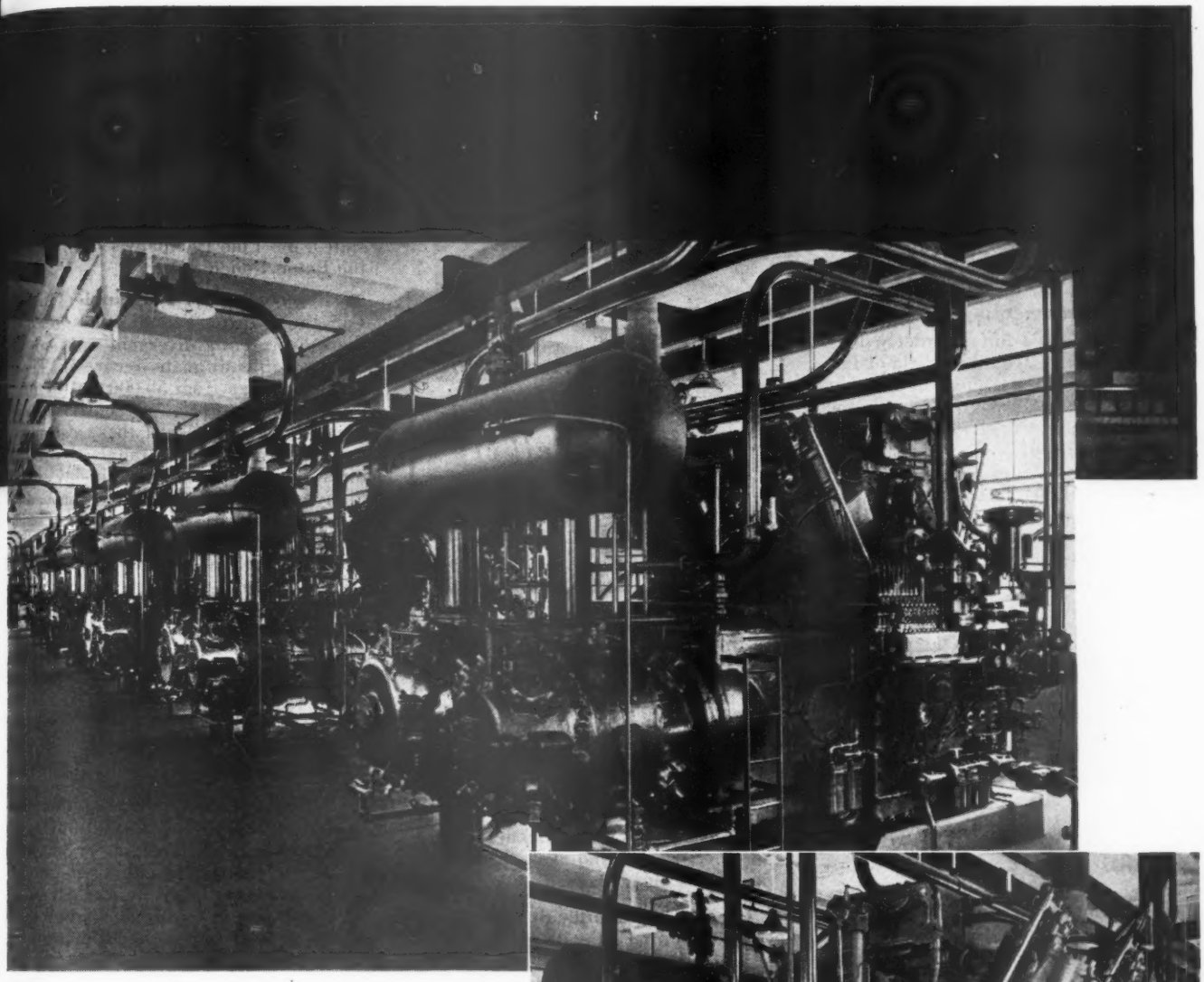
**4. AUTOMATIC CONTROL** . . . Due to their unusual versatility and responsiveness, G-MV units are especially suited to automatic control — a special phase of engineering highly developed by Cooper-Bessemer. In fact Cooper-Bessemer now offers a unique, fully proved system of interposing speed control between successive steps of unloading * to give a straightline control over virtually 100% demand, thus extending the advantages of speed control far below the limits previously practical with automatic control.

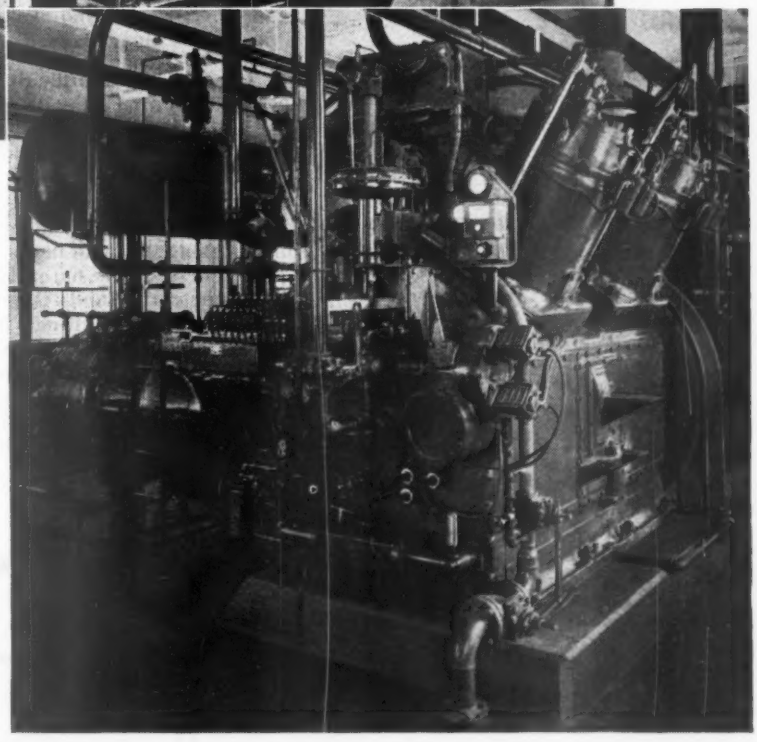
For detailed and profusely illustrated data on all features referred to above, and others besides, send along your request for the new 48-page G-MV bulletin. It's now on the press.

** Patent applied for*

Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.





*ABOVE:* Line of five 400 hp G-MV compressors in Continental Oil Company's new and complete 100 octane gasoline plant — the first plant in Oklahoma to manufacture the finished product. Here in this plant's T.C.C. compressor room, each compact V-type G-MV comprises a 2-stage compressor unit with low and high pressure cylinders.

*AT RIGHT:* Close-up of operating end of one G-MV. Note the diaphragm-operated, governor-type control mechanism for automatically maintaining constant pressure despite variations in demand.

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# HEIDELBERG—A MAJOR MISSISSIPPI OIL FIELD

By **K. MARSHALL FAGIN,** *Field Editor*

**EXCLUSIVE** With little fanfare but an orderly drilling program, the Heidelberg field of Jasper County has forged ahead of all other discoveries except Tinsley to become the second largest oil field in the State of Mississippi with 87 wells and 8000 bbl. daily production. In many ways it is still far from equalling Tinsley, the first and largest oil field yet found in this relatively new oil state, but it may ultimately produce nearly as much oil because of thicker producing sands. A comparison of Heidelberg with other Mississippi fields may be made by referring to Table I.

*Forging ahead with 4 to 8 new wells a month Heidelberg may finally yield as much as Tinsley.*

The Heidelberg field is located on a faulted dome with a graben separating the producing area into non-communicating east and west segments. The east segment was discovered by the Gulf Refining Company on January 27, 1944, when the Helen Morrison No. 1 was completed as a flowing well from Eutaw sand found at a depth of about 5000 ft. The west segment was also discovered by the Gulf Refining Company when its J. Morgan No. 1 was completed on June 16, 1944.

As indicated by the map, the east and west segments have been partially defined by dry holes. Many of these dry holes resulted from finding cross faults that complicate the geology of the main north-south faults on each side of the graben. In addition, the four pay sands are lenticular and exhibit considerable lateral gradation from sand of high permeability to sand of low permeability.

● **Four pay sands not segregated.** The four producing sands constitute four separate reservoirs in each segment. These are named the Morrison, City Bank, Stanley, and Christmas, but in each segment the four reservoirs are intercommunicating. This is the result of opening more than one of, and, in some cases, all the sands into a given well in order to assure a satisfactory completion. Although the water level is different in the two segments, the water level for all sands in a given segment is practically the same. As the various sands produce into common well bores, little additional difficulty is anticipated in controlling water encroachment.

● **Segments have different water levels.** The top of the Morrison oil sand in the east segment is approximately 4375 ft., or 4015 ft. subsea. The water level is about 5035 ft., or 4675 ft. subsea. This leaves a zone of some 660 ft. in which the four Eutaw sands are to be found. Frequently the sands have more than one layer of effective saturation. As many as eight layers of saturated sand have been perforated in some wells, so they would be able to produce their allowable.

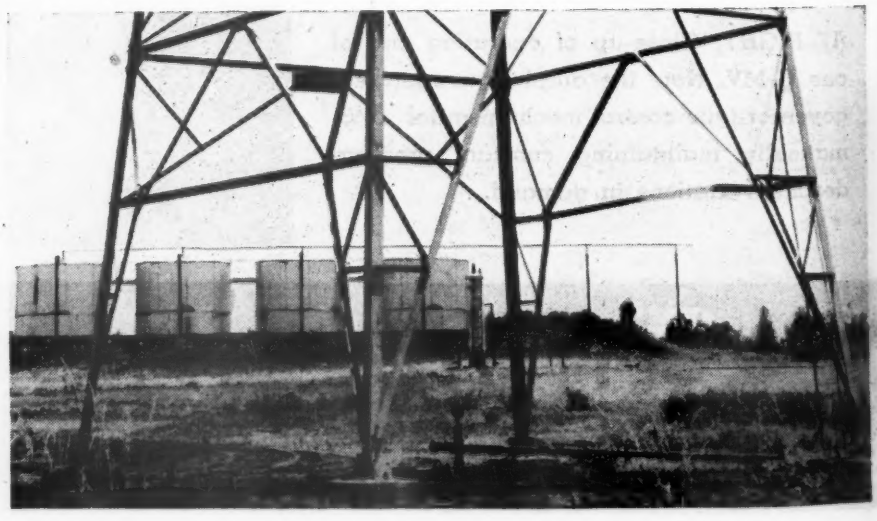
The top of the Morrison in the west segment is found at about the same depth as on the east segment, but the water level is 120 ft. lower. This increases the Eutaw zone thickness by the same amount, but the average oil sand thickness is about the same.

● **Oil recovery is difficult to estimate.** Estimates of total ultimate recovery from the Heidelberg field vary considerably at the present time. In the first place, recent extension wells to the north indicate the possibility of other extensions and further development of other fault blocks along the main faults. Second, the effectiveness of the natural water drive in sweeping the sands is problematical because of the faulting, lenticularity, and variable permeability of the sands. In the third place, the reservoir pressure is insufficient to provide many flowing wells. This is due, in part, to the small amount of solution gas in the oil, and to the low gravity and relatively high viscosity of the oil.

In the fourth place, the field has not been produced at full throttle as at Tinsley and the field's potential producing capacity is therefore not so evident. Lack of transportation facilities from the field is responsible for the relatively low rate of production. This situation will be eased soon by completion of the Interstate Pipe Line Company's 6-in. line to the Baton Rouge area.

● **Reserve estimates resemble Tinsley.** For the foregoing and other reasons there are greatly divergent opinions of the probable ultimate recovery. These opinions range from 50,000,000 to 105,000,000 bbl. for the presently proved area. In some respects, these estimates are reminiscent of the range of preliminary estimates on the Tinsley field. Many of the Tinsley estimates proved to be much too low, because even though the reservoir pressure declined sharply and most of the wells were on the pump soon after completion, the oil and water in the sands continued to be produced in large quantities due to the natural water drive. Like Tinsley, the oil produced at Heidelberg is accompanied by little gas, and the water production is increasing. Unlike Tinsley, the reservoir pressure has not fallen off rapidly due to the more limited transportation facilities.

Tinsley was rated by most authorities as a 60,000,000 to 100,000,000 bbl. field at the time it reached maximum development. The practically unlimited rate of production encouraged by war demands soon proved these estimates were low. With a present cumulative of more than 82,000,000 bbl. and a producing rate in excess of 9,000,000 bbl. per year, these estimates have been revised upward to current estimates of 110,000,000 to 125,000,000 bbl. Even these may prove somewhat too low before the last barrel is



**Gulf Refining Company No. 1 Helen Morrison, the discovery well of Heidelberg's east segment, was completed as a flowing well. Four 1000-bbl. tanks and a gas-oil separator appear in the background.**

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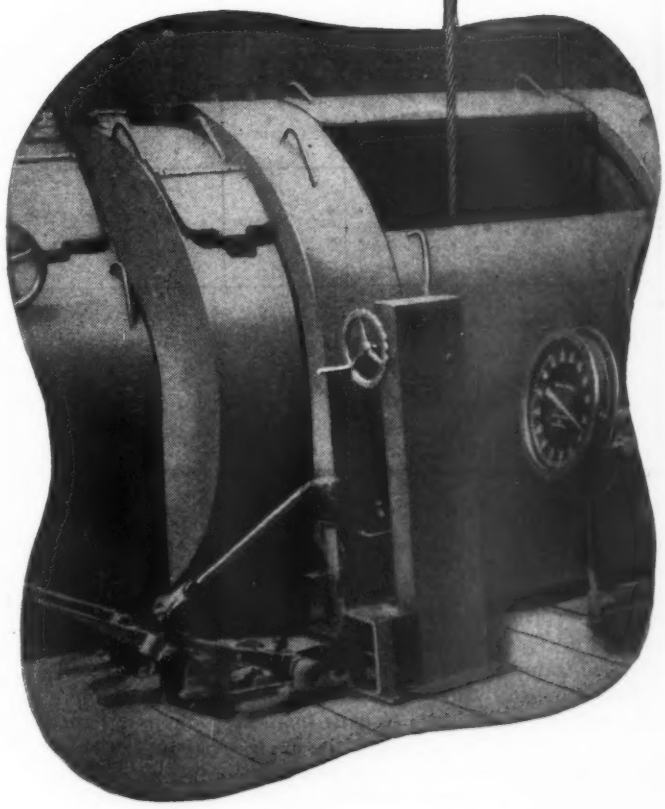

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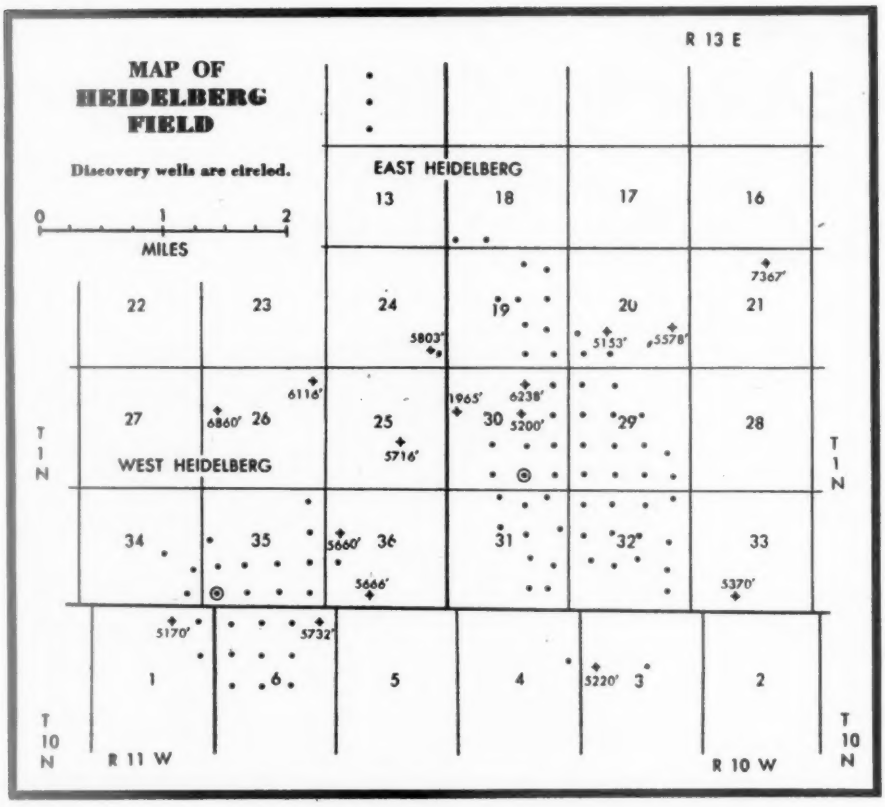



produced from the present producing sands in the field.

Reasons for the low preliminary estimates of Tinsley's ultimate recovery are plausible. The reservoir pressure had dropped rapidly, indicating a lack of sufficient natural water drive to produce effectively the oil known to exist in the saturated sands, In addition, the high rate of production promised to result in bypassing and inefficient flushing of the oil sands. This condition induced cautious estimates of the recovery factor. Furthermore, opinions of the effective sand thickness ranged from 50 to 100 ft.

● **Oil sand thickness an important factor.** The average effective thickness of oil sands in fields like Tinsley and Heidelberg that produce from several relatively thin pays in a zone several hundred feet thick is one of the main factors in an estimate. It can best be determined by the operators as development proceeds by a systematic program of coring, core analysis, and study of logs and cross-sections. Thickness estimates based on thorough studies would eliminate much guesswork on this important factor. In any case, the time to plan these studies is before the wells are drilled; otherwise, undue reliance must be placed on logs that often fail to reflect adequately the saturation and permeability characteristics of the oil sands.

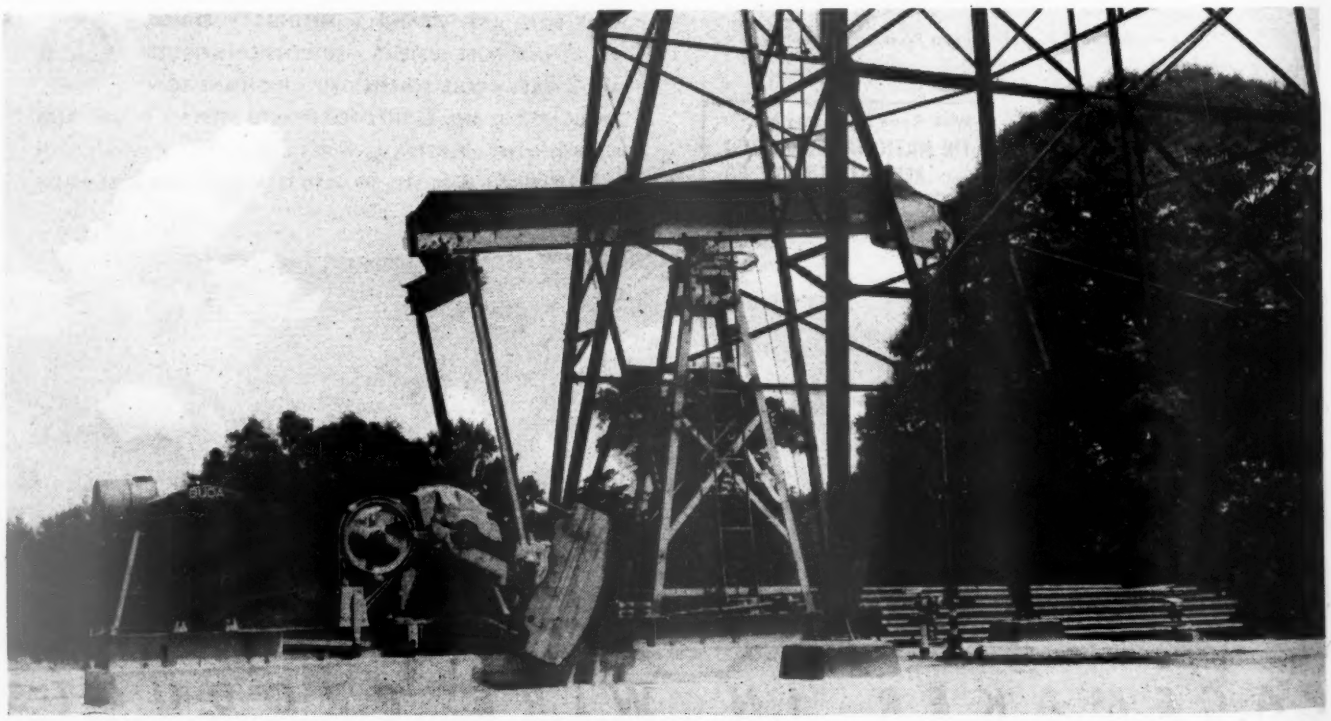
Sand thickness and other reservoir data are being carefully studied by the operators in the Heidelberg field, and on the basis of preliminary reports the average oil sand thickness is a little more than 130 ft. With 3500 acres producing now and probably 500 more proved for production, it is estimated the field contains about 520,000 proved acre-ft. of oil sand.

Analyses show the porosity averages more than 27 per cent; the connate water ranges from 30 to 55 per cent; the oil is 23° API gravity; shrinkage is about 12 per cent; and the range of permeability of the sand is from 5 to 3500 millidarcys. The gas-oil ratios range from 70 to 160 cu. ft. per bbl.

● **Factors indicate 100,000,000 bbl. yield.** On the basis of the following factors, the ultimate yield from the Heidelberg field would be 100,000,000 bbl. of oil: (a) 4000 proved acres, (b) 100 ft. of "effective" oil sand, (c) 50 per cent connate water, (d) 25 per cent porosity, (e) 12 per cent shrinkage, and (f) 29 per cent recovery.

Recovery of 100,000,000 bbl. would equal an average yield of 250 bbl. per acre ft., or 25,000 bbl. per acre, or

**Typical twin-crank pumping unit at work on a well in the Heidelberg field. Multicylinder engine drives the unit through V-belts. Note unitized foundation and water reservoir for the engine radiator mounted on a stand constructed of pipe.**



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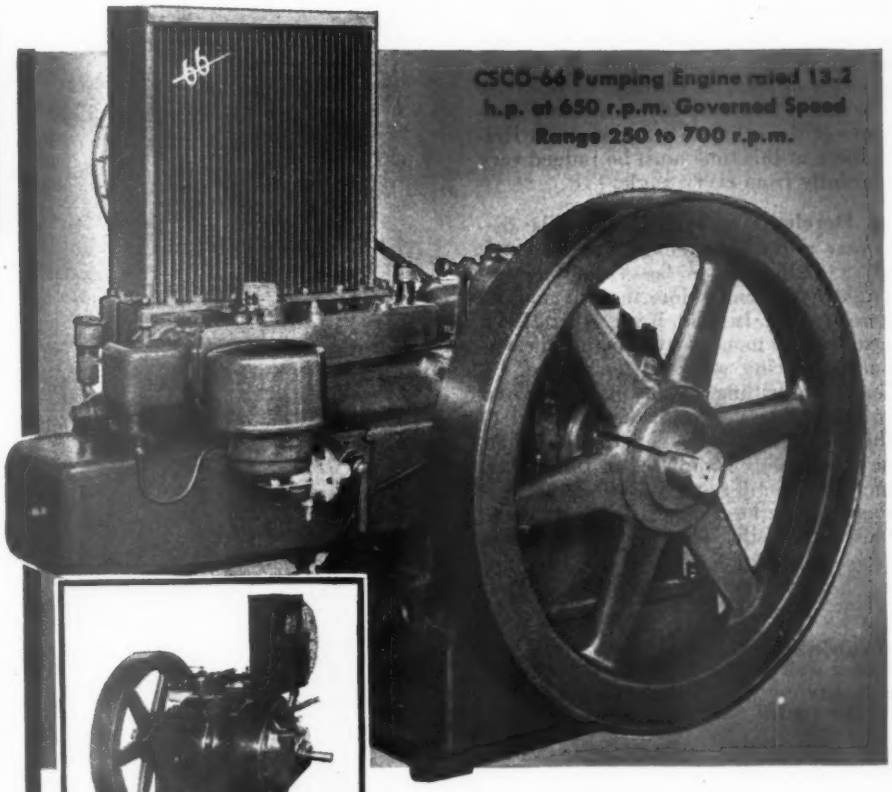
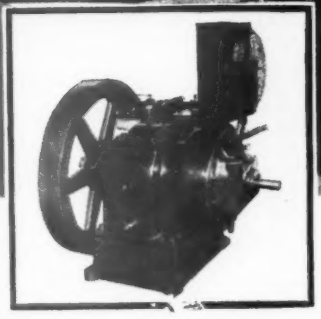
13. Extra heavy crankshaft mounted on over-size Timken roller bearings.
14. Oversize connecting rod bearing insures long life.



CSCO-66 Pumping Engine rated 13.2 h.p. at 650 r.p.m. Governed Speed Range 250 to 700 r.p.m.



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1,000,000 bbl. from each well (based on the present spacing of one well to every 40 acres).

Unless the effectiveness of the natural water drive should fail to come up to expectations (based on comparison with Tinsley), it is apparent that those who predict 100,000,000 bbl. ultimate recovery for Heidelberg have the facts to support their estimates.

● **Heidelberg's producing ability awaits test.** We must remember, however, that with a present cumulative of only 3,000,000 bbl. and a present annual producing rate of about 3,000,000 bbl., we have not yet begun really to test the efficiency of the water drive. The field would have to produce more than 32 years at 3,000,000 bbl. per year to yield the 97,000,000 bbl.-remainder of such an estimate. Much could happen in that length of time to necessitate downward revision of such an estimate of reserves. For many reasons, therefore, any estimate of the utlimate recovery from Heidelberg at this time must be judged very carefully from every angle.

● **Development of the field.** The discovery well in Heidelberg did not touch off a drilling boom as a similar well might have done before the war and 40-acre spacing. Instead, it was April, 1944, nearly three months later, before the second producing well was completed. By that time drilling activity had increased so that three new wells were added to the field during the next month. Four new wells were completed in June, 1944, including the discovery well of the west segment of the field. Then, eight were finished in July. This performance was repeated in August. The peak of drilling activity was being reached at that time. This peak resulted in 10 new wells being completed in October and 10 in November. From then until now, new producing wells have been added steadily, but in smaller numbers. Some of the 20 or more rigs used in drilling the field have been moved to other areas or temporarily stacked.

Both power and steam rigs were used in drilling these 5000-ft. Eutaw sand wells. The drilling time ranged from 25 to 45 days depending among other things on the way arrangements were made for rig fuel (gas from the oil wells being insufficient); the kind and condition of the rig being used, and the amount of coring, gun perforating, and other work required to complete the well flowing or on the pump. The drilling time given above does not include road building, or rigging up time yet difficulties in reaching the location and setting-up sometimes took as much time as to drill and complete the wells.

**Running 10¾-in. surface pipe into a well in the Heidelberg field with a power type drilling rig using oil for fuel.**

● **Casing and cementing practice.** Most wells are equipped with a 1000-ft. string of 10¾-in. O.D. 40.5-lb. seamless surface pipe cemented to the surface with 500 sacks of cement. This is set in hole made with 15-in. rock bits. Three bits are usually needed to drill this section.

The oil strings are usually either 7-in. O.D. 23-lb. J-55 8-thread seamless or 7-in. O.D. 26-lb. grade "D" 10-thread seamless pipe. A few wells are equipped with 5½-in. O.D. 15.5-lb. J-55 8-thread seamless pipe, but, due to the prospect of having to pump most of the production plus considerable water, most of the operators have installed 7-in. pipe. This is practically always set through the pay sands to the total depth of about 5000 ft. with from 400 to 800 sacks of cement in a hole drilled with 9⅞-in. rock bits. Ten to 25 bits may be needed to drill this section.

Selected strata of the oil sands are generally opened with about 6 shots per ft. by gun perforators. A typical perforating job is as follows:

| *Feet* | | | *No.* |
|---|---|---|---|
| *from* | *to* | *th.* | *shots* |
| 4695 | – 4708 | 13 | 90 |
| 4852 | – 4858 | 6 | 36 |
| 4872 | – 4877 | 5 | 30 |
| 4894 | – 4905 | 11 | 66 |
| 4919 | – 4933 | 14 | 84 |
| 4942 | – 4962 | 20 | 120 |
| Total | | 69 | 426 |

Tubing was run in the above well to a depth of 4751 ft. A production packer was set at 4673 ft. The well flowed 124 bbl. of 23-deg. API gravity oil through a 10/64-in. choke during the initial 24-hr. test with flowing tubinghead pressure of 130 lb. per sq. in.

● **Pumping equipment needed early.** Most wells are equipped with 2½-in. 6.5-lb. external upset tubing and production packers. About half the wells were completed as weak flowing wells, but less than one-third of the 87 wells are flowing now. Nearly all are either equipped or being prepared for a long pumping life.

The original bottomhole pressure has been estimated as 2120 lb. per sq. in. gage at 4674 ft. subsea in the east segment of the field. This is equivalent to a gradient of 0.42 lb. per ft. from the surface to a depth of 5035 ft. A pressure survey in December, 1944, indicated a decline of 40 lb. per sq. in. Another decline of 40 lb. was indicated by February, 1945. These declines by themselves can hardly be considered significant. The way the reservoir pressure will behave after the field is completely developed and working differential pressures are

*(Continued on Page 74)*

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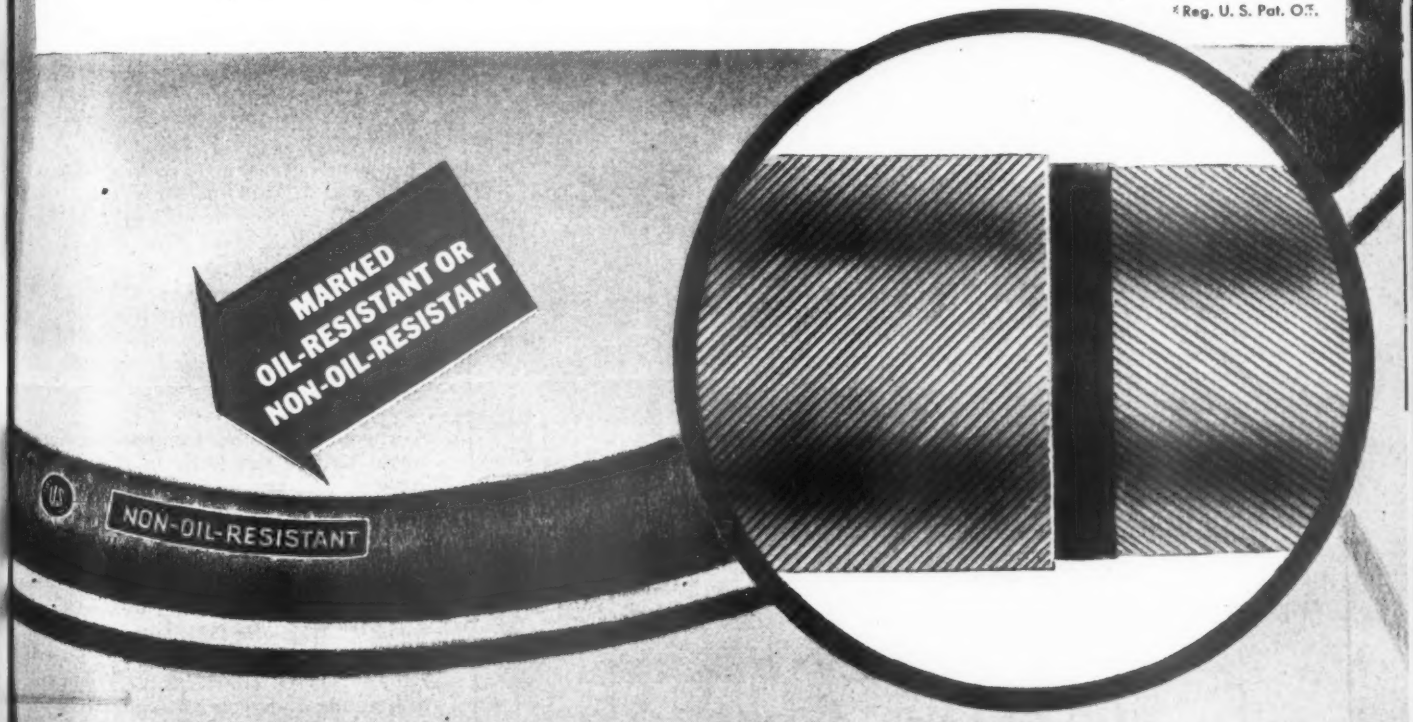


# STATES RUBBER COMPANY

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TABLE 1
The oil and gas fields of Mississippi.

| County | Field | Date of discovery | Operator | Well | Location | Producing formation | Depth, ft. | API gravity, deg. | No. of wells | Acreage assigned | Oil production, bbl. | | Gas production, million cu. ft. | | Est. daily water prod., bbl. | Est. ave. gas-oil ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Daily | Cumulative | Daily | Cumulative | | |
| Adams | Carthage point | 1-12-45 | Pure | McDowell 2 | 12- 6N- 3W | Basal Tuscaloosa | 10,280 | 54 | 1 | 640 | 150 | 20,000 | 1.8 | 240 | 0 | 12,000 |
| Adams | Cranfield | 10- 6-43 | California Company | National Gasoline 1 | 52- 7N- 1W | Wilcox<br>Tuscaloosa | 5,900<br>10,500 | 42<br>39 | 26 | 1,040 | 5,500 | 1,500,000 | 11.0 | 3,000 | 20 | 2,000 |
| Claiborne | Bruinsburg (gas) | 11-29-44 | Sun | Hammett A-1 | 2-11N- 1W | Moody Branch | 940 | .. | 1 | 80 | gas | ..... | .. | 1 | ..... | ..... |
| Clarke | Langsdale | 1-20-45 | Kirby | Long Bell 1 | 30- 1N-18E | Eutaw | 3,700 | 19 | 5 | 200 | 300 | 33,000 | .. | 1 | 30 | 25 |
| Hinds-Rankin | Jackson (gas) | 2-16-30 | Cleve Love | Mayes 1 | 2- 5N-1E | Selma | 2,400 | .. | 19 | 7,000 | gas | ..... | 3.0 | 116,000 | ..... | ..... |
| Jasper | Heidelberg, East | 1-27-44 | Gulf | Morrison 1 | 30- 1N-13E | Eutaw | 5,000 | 23 | 62 | 2,480 | 5,700 | 2,410,000 | 0.8 | 370 | 350 | 150 |
| Jasper | Heidelberg, West | 6-16-44 | Gulf | Morgan 1 | 35- 1N-12E | Eutaw | 5,100 | 23 | 25 | 1,000 | 2,300 | 580,000 | 0.3 | 90 | 300 | 150 |
| Jasper | Soso | 3-16-45 | Gulf | Edwards-Bailey U. 1 | 27-10N-13W | Basal Eutaw | 6,600 | 67 | 1 | 320 | shut in | ..... | .. | .... | 0 | 32,000 |
| Jefferson Davis | Gwinville | 7-26-44 | Richardson | C. E. Berry 1 | 24- 9N-19W | Eutaw<br>Tuscaloosa | 8,100<br>9,200 | 59<br>40 | 6 | 960<br>240 | 400 | 45,000 | 2.0 | 400 | 0 | 140,000<br>60 |
| Lamar | Baxterville | 11-18-44 | Gulf | Cooper 1 | 7- 1N-16W | Upper Tuscaloosa<br>Basal Tuscaloosa | 8,700 | 52<br>18 | 4 | 960<br>160 | 100 | 30,000 | 2.0 | 350 | 0 | 90,000<br>230 |
| Lincoln | Brookhaven | 3-10-43 | California Company | Smith 1 | 4- 7N- 7E | Basal Tuscaloosa | 10,200 | 24 | 1 | 40 | 30 | 26,000 | .. | 8 | 0 | 300 |
| Lincoln | Mallalieu | 8-24-44 | California Company | Douglas 1 | 10- 6N- 8E | Basal Tuscaloosa | 10,550 | 38 | 3 | 120 | 300 | 103,000 | 0.1 | 41 | 180 | 400 |
| Madison | Flora | 9- 7-43 | Love Petroleum | Anderson 2 | 2- 8N- 1W | Selma Chalk | 4,360 | 27 | 2 | 80 | 20 | 14,000 | .. | 1 | 300 | 30 |
| Madison-Yazoo | Pickens | 4-22-40 | Kingwood & Exchange | Wilburn 1 | 31-12N- 3E | Eutaw | 4,800 | 40 | 43 | 1,680 | 5,700 | 5,800,000 | 0.7 | 685 | 5,900 | 120 |
| Marion | Hub | 3- 3-45 | Humble | Evans 1 | 15- 2N-18W | Basal Tuscaloosa | 9,100 | 50 | 1 | 320 | 60 | 3,000 | 1.2 | 60 | 0 | 20,000 |
| Sharkey | Cary | 7-31-41 | British American | Houston A-1 | 23-11N- 7W | Selma Chalk | 3,260 | 25 | 2 | 80 | 25 | 46,000 | .. | 9 | 650 | 200 |
| Wayne | Eucutta | 9- 3-43 | Gulf | Aden Davis 1 | 2- 9N- 9W | Eutaw | 6,850 | 22 | 70 | 2,660 | 6,400 | 1,540,000 | 0.2 | 54 | 600 | 35 |
| Yazoo | Tinsley | 9- 5-39 | Union Production | Woodruff 1 | 13-10N- 3W | Selma chalk | 4,000 | 34 | 300 | 10,940 | 25,500 | 82,440,000 | 1.2 | 5,770 | 34,000 | 70 |
| Total Mississippi | | | | | | | | | 572 | | 52,435 | 94,590,000 | 24.3 | 127,080 | 42,330 | |

*(Continued from Page 70)*

established will be more indicative of the effectiveness of the water drive.

Water production from the field has increased from month to month, but is not a serious problem at present. About half the wells now produce a little water along with the oil, and most of these produce only a few bbl. of water daily. Most of the water comes from a few edge wells. One well in the west segment accounted for 90 per cent of the water produced by all 6 wells reporting water in that segment during a recent month.

● **Water production not serious now.** Twelve wells in the east segment produced an average of 20 bbl. water daily or 80 per cent of the water made by all 34 water wells in that segment during the same month. The other 22 wells made less than 10 bbl. of water daily. The biggest water well in the east segment made about 50 bbl. of water daily with 100 bbl. of oil.

Treating systems are installed at most tank batteries, but little difficulty is encountered at present in separating the oil and water.

Most of the pumping wells are equipped with 94-ft. 330,000-lb. galvanized angle iron derricks, concrete floors, and pumping units driven by multi-cylinder gas engines. The units and engines are usually mounted on a common I-beam base that is set on a concrete foundation. Several kinds of rods and oil well pumps are being used. Many 2-in. insert type pumps are being used, but some 2¼-in. common working barrel pumps are installed in the 2½-in. tubing. With the current high fluid levels in some wells, the pumps are sometimes set 500 ft. or more off bottom.

When operated at 15 or 16 strokes per min. and a 54-in. polished rod stroke, the wells produce from 50 to 300 bbl. of oil per day. Considerable difficulty is sometimes had in opening up the oil sands enough to obtain a 100-bbl. well. In these cases, the oil sands are usually reperforated and the wells tested by swabbing before the pump is installed. The completion process sometimes takes as much time as drilling.

The Gulf Refining Company operates about half of the wells in the field at present. The remainder of the wells are operated by the following companies: Fair & Billings, 2; Fohs Oil Company, 4; Frank & George Frankel, 4; Graham & Lewis, 1; Claud B. Hamill, 1; Hassie Hunt Trust, 1; W. B. Johnston, 1; Kingwood, 2; Magnolia Petroleum Company, 2; Midstates Oil Corporation, 3; Rogers Lacy, 6; P. G. Lake, Inc., 3; Lion Oil & Refining Company, 2; Sinclair-Wyoming Oil Company, 1; Sun Oil Company, 4, and Tide Water Associated Oil Company 1.

Although the field activity centers around the town of Heidelberg, many of the operations are handled from company field offices at Laurel, about 14 miles south, or from district offices at Jackson, which is approximately 100 miles northwest of the field. ★★★

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# BAYWAY UNIT HOLDS U. S. POLYMER MAKE RECORD

By **JOHN H. KUNKEL,** *Refinery Editor*

**EXCLUSIVE** FIVE O'CLOCK on the morning of October 31, 1941, was an auspicious moment at the Standard Oil Company of New Jersey refinery at Bayway, New Jersey. At that hour, on that date, Jersey Standard placed its then new polymerization plant on stream that:

*(a) On April 30, 1945—3 years and 6 months later—was still on stream with a record of 30,600 continuous hours of operation with every evidence that the run can be continued until an arbitrary decision to take the plant off stream is made, and,*

*(b) As a result of this continuous run, Jersey Standard's Bayway refinery has earned the distinction of having made more polymer product than any other U. S. refinery; the polymer being shipped to Jersey's refinery at Baton Rouge, Louisiana, as feed for that refinery's hydrogenation plant making hydro-polymer.*

*In addition, the Bayway poly plant's effluent representing concentrated isoC$_4$ is shipped to Jersey's Baltimore refinery for alkylation. Therefore, in combination with its polymer make, the plant has contributed materially to Bayway's participation in the 100-octane aviation gasoline program and the war effort.*

Table I details the history of the polymerization plant's run during the first 3 years (to October 31, 1944) in terms of fresh $C_4$ charged, polymer made, yields, average conversion of unsaturates, inspections of the hydrocodimer cut, catalyst consumed, and gallons of polymer made per barrel of catalyst consumed.

The plant was designed by Jersey Standard's process engineering department and built by Foster Wheeler Corporation. UOP catalyst is employed in the reactors, and, the reactor cooling system is licensed by The Barrett Division, Allied Chemical and Dye Corporation.

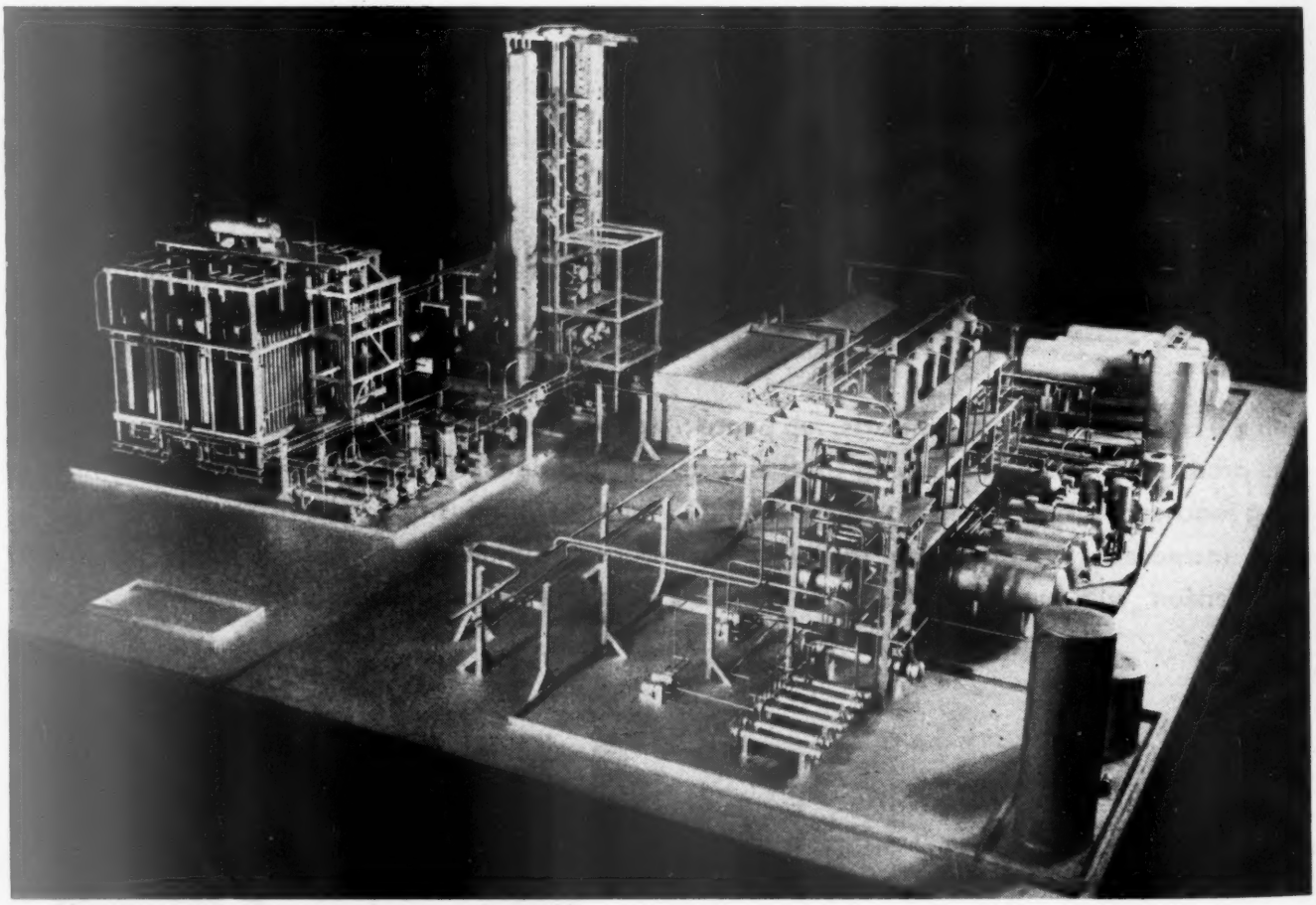
Originally, the plant was designed for a non-selective operation polymerizing propylenes and butylenes for motor gasoline, and it likely will be so operated in postwar. Just before the plant went on stream in 1941, as a means of making its products available to the 100-octane program, the $C_3$ stream was eliminated from the plant's feed so that a selective operation, combining n-butylene and isobutylene to form an unsaturated octane, could be conducted.

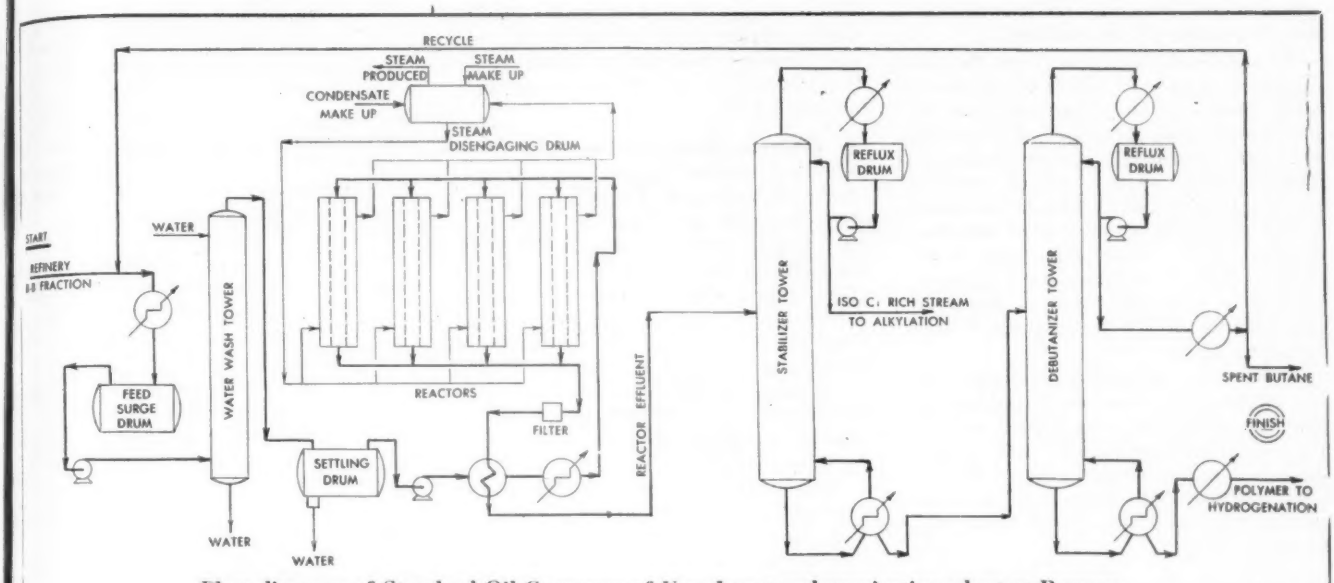
● **Feed.** For the selective operation, the feed is $C_4$ originating in the Bayway refinery, off-site from the polymerization plant, and, processed off-site for the production of a 98-99 per cent-pure $C_4$ feed stock.

Pressure distillate from the cracking coils in the refinery's thermal cracking units pass through a splitter, the bottoms from which are $C_4$-free, and the overhead a $C_1$-$C_6$ + fraction. Downstream this splitter overhead is joined by a $C_1$-$C_4$ cut, rich in percentage of isoC$_4$, from the refinery's fluid catalytic cracking unit and the combined streams enter a stabilizer for the overhead rejection of the $C_1$-$C_3$ fraction as required by the selective operation in the poly plant.

Bottoms from the off-site stabilizer, a $C_4$-$C_6$ + fraction, enter a debutanizer where the $C_5$-$C_6$ + fraction is rejected while the overhead, after being con-

**Scale model of Bayway plant made by Foster-Wheeler Corporation now is part of the permanent petroleum industry exhibit in the Smithsonian Institute. Reactors at extreme left show tube arrangement. Fractionation section is at the left center and feed preparation section is at the right.**






**Flow diagram of Standard Oil Company of New Jersey polymerization plant at Bayway.**

densed, is liquid $C_4$. This stream splits with part going to the refinery's chemical products plant and the remainder—approximately 8000 gal. per hr.—going to the polymerization plant as feed. The feed as stated is 98-99 per cent $C_4$, the unsaturates approximating 40 per cent. Ratio of isobutylene to n-butylene is 1:2.

● **Flow.** The polymerization plant has 3 sections, as follows:

1. Feed preparation consisting of storage drums, feed cooler, feed surge drum, water-wash tower with settling drum, feed heat exchangers, reactor feed preheater and supporting pumps; these units being those used during the selective operation.

2. Reactor section consisting of 4 reactors, effluent filter, a condensate gathering system, and a steam disengaging drum.

3. A fractionation section consisting of a stabilizer and debutanizer, their reboilers and overhead condensing systems, distillate collecting drums, reflux pumps and aftercoolers.

The plant's feed is collected in 3 storage drums from which it is pumped to join a recycle stream that is a portion of the overhead products from the fractionation section towers amounting to approximately 6000 gal. per hr. This recycle stream is 90 per cent saturated $C_4$ plus 10 per cent unsaturates.

The combined fresh feed and recycle pass through a cooler using salt water as the cold medium, and at a temperature of 90-100°F. the stream enters a feed surge drum. The 3 feed storage drums, together with the feed surge drum, have a combined capacity of 80,000 gal.

A transfer pump takes suction on the feed surge drum, and the feed is passed through a water-wash drum for the removal of nitrogen compounds, after which it passes to a settling drum where the water is rejected.

The feed in the settling drum is at a pressure of 140 lb. per sq. in. gage* and a temperature of 110°F.

*All pressures are in lb. per sq. in. gage.

As the ensuing reaction is a high-pressure operation, a 20-stage centrifugal pump takes suction on the settling drum, increasing the feed pressure to 600-900 lb., the exact pressure being governed by the temperature of the reactor, before passing it through 3 feed heat exchangers in series as the cold medium.

The hot medium in the exchangers is effluent from the reactors at a temperature of 310-390°F. The temperature of the feed out of the exchangers is about 280°F., and the flow now is to a feed preheater using high-pressure steam from the steam disengaging drum in the reactor section. The temperature of the feed from the preheater is held constant at 10°F. below that of the outlet temperature of the reactors by a temperature recording control in the steam transfer line from the disengaging drum which, in turn, is controlled by a pressure recording control. From the preheater, the now conditioned feed flows to the reaction section.

● **Reaction section.** There are 4 reactors in parallel, with 3 constantly on stream while the fourth is down for change of catalyst. When catalyst has been changed in a down reactor, it is reserved for standby service until it is time for renewal of catalyst in one of the remaining 3 reactors, when it is returned to service. The catalyst in each reactor is changed after it has completed a run of 1000-1500 hr. The time for change of catalyst is indicated by several factors: Evidence of a high pressure drop across the reactors; temperature loss, and/or hydrocarbon analysis showing presence of isobutylenes in the reactor effluent.

Each reactor contains 3 vertical tube bundles, arranged for parallel flow, with 20 catalyst-filled, parallel connected tubes each measuring 24 ft. by 5 in. I.D., to a bundle. Each tube is encased within a condensate jacket. A 3-in. filler bar may be inserted in each of the tubes, but, at present, filler bars are not used and the catalyst bed extends the full length, and across the diameter, of the tube. Feed flow is overhead to a reactor, to a tube bundle and down through a single tube.

● **Reactor cooling cycle.** The reactor temperature is 310-390°F. The reaction is exothermic, and the heat of reaction is dissipated by means of a closed reactor cooling system.

The cooling system consists of a condensate collecting drum that receives condensate from the fractionation section reboilers, from which make-up condensate is pumped to a steam disengaging drum. Condensate off the bottom of the drum flows to the reactors, to the bottom of the condensate jackets surrounding the tubes, the heat of reaction forming a thermal syphon that returns to the steam disengaging drum

**TABLE 1. U. O. P. Poly plant rates as of October 31, 1944.**

| Year | First | Second | Third |
|---|---|---|---|
| Fresh $C_4$ charged, total bbl | 789,302 | 1,717,166 | 2,403,738 |
| Bbl. per day | 2,152 | 4,705 | 6,568 |
| Selective poly. product, total bbl. | 248,769 | 568,701 | 592,238 |
| Bbl. per day | 682 | 1,558 | 1,618 |
| Yield, per cent on fresh feed | 31.9 | 33.1 | 24.6 |
| Average conversion of unsats., per cent on fresh feed | 73 | 75 | 65.3 |
| Hydrocodimer cut | 150-270°F. | 150-270°F. | 150-360°F. |
| ASTM octane no. (clear) | 93-94 | 93-94 | 93 |
| 1-C O. N. (+4.0 cc. Tel) (blend val.) | 103-105 | 103-105 | 105† |
| 3-C O. N. (+4.0 cc. Tel) (St. 4 blend val.) | 102-105 | 102-105 | 104 |
| U. O. P. catalyst consumed (lb.) | 96,300 | 242,600 | 161,790 |
| Gal. poly per lb. catalyst | 108 | 98 | 154 |

*First year November 1, 1941 to October 31, 1942. Second year—November 1, 1942 to October 31, 1943. Third year—November 1, 1943 to October 31, 1944.
†Straight rating.

where steam formed by the heat of reaction is separated from condensate.

An overhead steam line from the disengaging drum goes either to the previously mentioned feed preheater in the feed preparation section or, if an excess of steam is produced, to the refinery's 110-lb. steam system or to exhaust steam. If insufficient steam is produced by the heat of reaction due to low conversion, or if a high steam rate is required to the preheater in the feed preparation section, provision is made to bleed 110-lb. or 600-lb. steam to the disengaging drum.

A pressure recording controller on the disengaging drum steam production line establishes the steam pressure for the entire cooling system, and, consequently, sets the temperature of the reactor cooling water as well as the temperature of the steam to the feed preheater.

● **Fractionation.** Effluent from the reactor tubes gathers in a common line, and passes through a filter containing glass wool for the removal of any entrained catalyst fines, after which it flows through the previously mentioned feed heat exchangers, then through a debutanizer preheater in which the hot medium is condensate from the fractionation section's reboilers and thence to the fractionation section.

● **Effluent fractionation.** The fractionation section consists of stabilizer and a debutanizer. The dimensions of these columns are identical: 74 ft. high by 6 ft. I.D., and each contains 30 plates on 24-in. centers. Each of the columns is equipped with an individual kettle-type reboiler, and each has its own overhead condensers, distillate accumulator drum, and overhead product aftercooler. A bottoms product aftercooler serves the debutanizer and it is so arranged that should the debutanizer be down it can serve the stabilizer.

The fractionation section piping is so arranged that, when the selective operation is conducted, the stabilizer and debutanizer can be used in series and, further, so that either one of the columns alone can be used without suspending the make of polymer product should the other column be down.

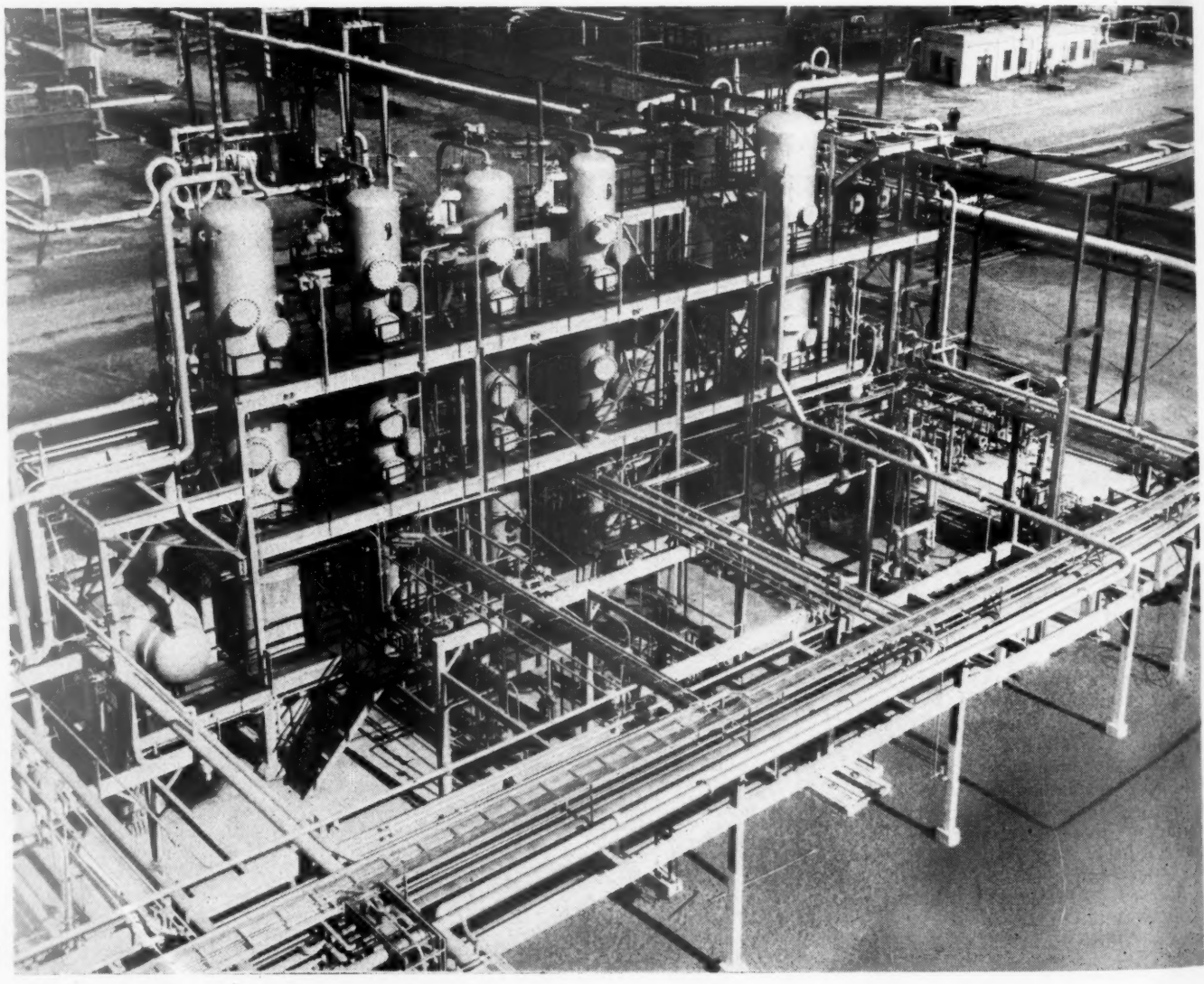
When conducting the selective operation, effluent from the reactor section flows to the stabilizer, entering over its 15th plate. The stabilizer is designed for a pressure of 250 lb. Its temperatures are: Bottom, 245°F.; top, 120°F.

Stabilizer overhead, concentrated iso$C_4$, passes through 2 salt water-cooled condensers in series to the distillate drum whence a portion of the distillate is pumped back over the tower top as reflux while the excess goes either to the stabilizer's overhead product aftercooler and to storage for subsequent shipment to Jersey's Baltimore refinery for alkylation, or to join the distillate from the debutanizer overhead and with it to pass through the debutanizer's overhead aftercooler, thus becoming part of the recycle product that joins the fresh feed to the plant.

Bottoms from the stabilizer, containing a part of the $C_4$ and polymer, pass through its kettle-type reboiler. There is no pump around from the reboiler back to the stabilizer. A wier retards liquid-flow across the reboiler to permit flashing off of vapors that flow under their own pressure back to the stabilizer bottom. Liquid overflowing the wier passes from the reboiler bottom to the debutanizer.

The debutanizer is designed for a pressure of 75 lb. Its temperatures are: Bottom, 325°F.; top, 125°F.

Feed to the debutanizer enters over its 15th tray. The debutanizer overhead product is concentrated n-butylene and saturated $C_4$, which is condensed and



**Feed preparation unit.**

# Welding Fittings Information

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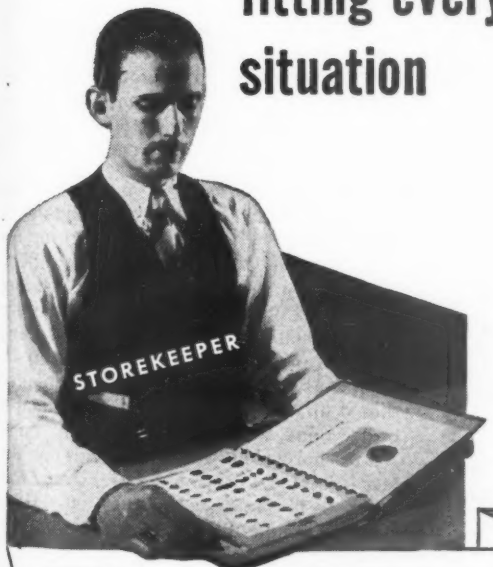


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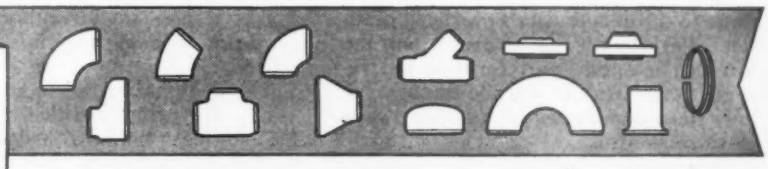
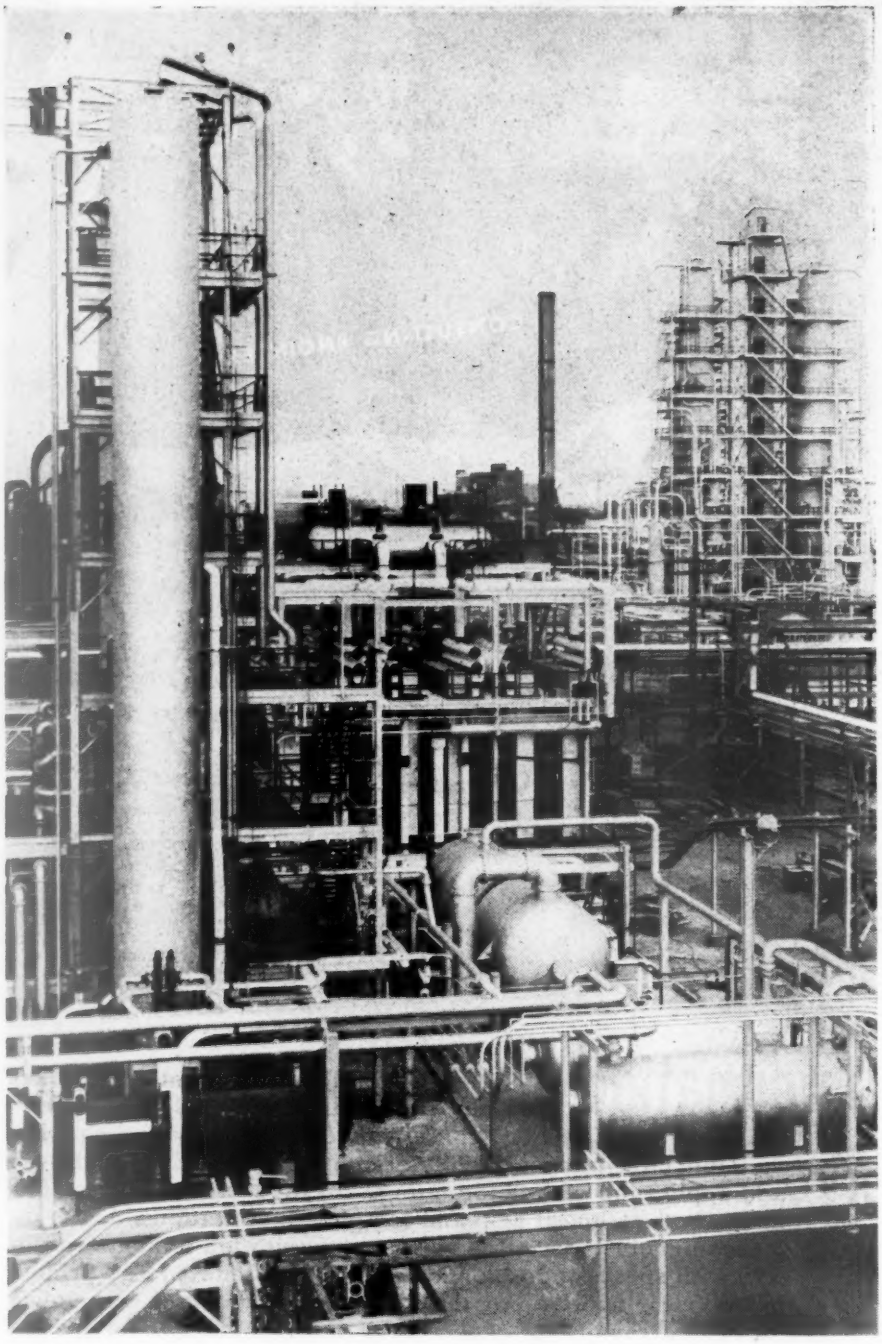


**THE COMPLETE LINE OF WELDING FITTINGS AND FLANGES**



Reactors and towers.

goes to that column's distillate drum. Any gas from the distillate drum goes to the gas absorption plant. The distillate drum temperature is so controlled, however, that little or no gas forms.

A reflux pump takes suction on the distillate drum to return a portion of the distillate back over the tower top as reflux, while the remainder, which may be joined by excess stabilizer distillate, flows to the debutanizer's overhead product aftercooler. The stream from the aftercooler splits, part forming the recycle to the fresh feed while the balance goes to storage for motor gasoline vapor pressure control.

Debutanizer bottoms, the polymer product, pass through that column's kettle-type reboiler, identical with that serving the stabilizer, are aftercooled, and go to storage for shipment to the hydrogenation plant in Jersey's refinery at Baton Rouge, Louisiana.

● **Plant design responsible for long run.** The plant's long run is due to its design, which permits the bypassing of all individual drums, reactors, and columns. Thus, any of these units can be taken out of service without shutting down the entire plant.

In the selective operation, the series use of the stabilizer and debutanizer makes it possible for either column to be down without interrupting polymer make.

The debutanizer, for example, can be taken off stream, in which circumstance the stabilizer bottoms, instead of going to the debutanizer as feed, bypass that column and, as polymer product, go to the debutanizer bottoms aftercooler and then to storage. Conversely, the stabilizer can be taken off stream by directing the reactor effluent into the debutanizer. When either column is off stream while polymer make continues, however, it is impossible to concentrate isoC$_4$ for shipment to Baltimore.

Since, as has been pointed out, either column may be off stream without interrupting polymer make, the reader may query: "Why the stabilizer?"

The answer checks back to the fact that:

(1) In the non-selective operation for which the plant originally was designed, a mixture of C$_3$ and C$_4$ is fed to the reactors where a polymer of C$_3$ and C$_4$ is formed. The effluent from the reactors, which then contains a mixture of C$_3$, C$_4$ and polymer, is delivered to the stabilizer, the function of which is to remove the C$_3$ as an overhead cut. The bottoms from the stabilizer, which contain a mixture of C$_4$ and polymer, are then delivered to the debutanizer, where the butane is removed as an overhead cut and the polymer as a bottoms. Inasmuch as no C$_3$ is fed to the reactors in the selective operation, this tower is available for removing a concentrated stream of isobutane for delivery to Jersey's Baltimore Refinery for alkylation.

(2) Although the primary objective of the selective operation is that of making polymer for Baton Rouge, the secondary, and equally important objective, is that of concentrating as much isoC$_4$ as possible for the Baltimore refinery, which normally is not a function of the poly plant.

(3) The polymerization plant, as originally designed for a non-selective operation, was not built to handle 16,000 gal. per hr. of C$_4$ feed as is handled in the selective operations; therefore, the debutanizer overhead product condensers alone are not sufficient in their capacity during summer months.

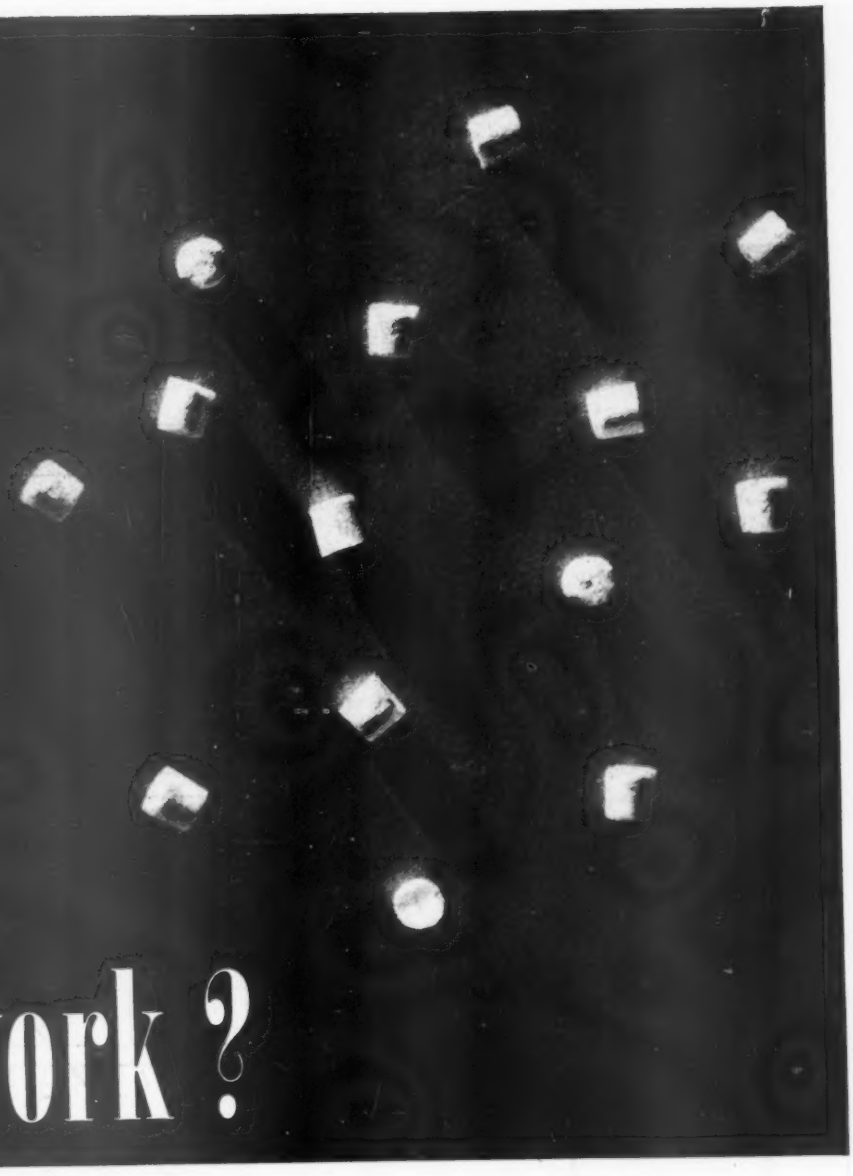
The flexibility of the plant's design enabled the stabilizer to be placed in series use with the debutanizer, thus making the present selective operation possible, and, at the same time, contributing in a large way toward the plant's long, continuous run.

● **Metal inspections:** As a result of this flexibility in design, the plant has been metal inspected twice since going on stream without interrupting its operation. The first such inspection took place at the end of the first year, whereas the second occurred at the end of the second year. Transfer lines were not metal inpected at either time as it is contended that if no corrosion is found in the major units, none will be found in the lines. As no corrosion was found during the last metal inspection, a decision was reached to conduct future inspections only at the end of 2-year intervals.

● **Acknowledgments.** The writer desires to acknowledge the contribution of J. B. Hanna, technical assistant, Standard Oil Company of New Jersey, Bayway Refinery, who supplied the data from which this article was written.

★★★

# Why not let the catalyst do the work?



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# ORIFICE METER PRESSURE EXTENSION CHART

By **W. F. MARTIN**
*Texoma Natural Gas Company*

**EXCLUSIVE** THE accompanying chart is based on the formula:

$Q = c(hp_a)^{\frac{1}{2}}$.

Where: Q = volume of gas, in cu. ft. at a temperature of 60°F., of a specific gravity of 0.600, and on a pressure base of 16.4 lb. per sq. in. abs.

h = differential in inches of water, and

$p_a$ = static in lb. per sq. in. gage + 13 lb.

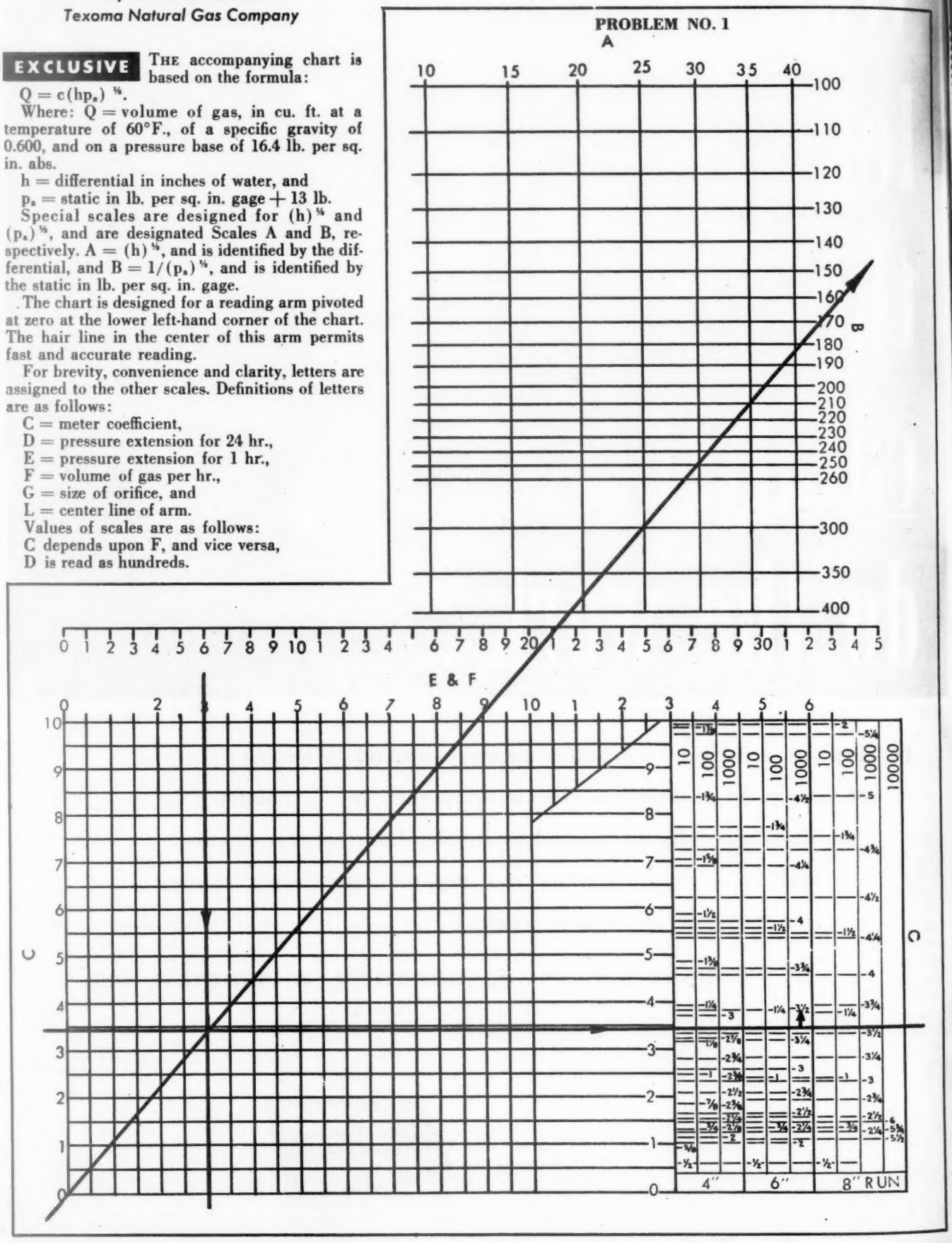
Special scales are designed for $(h)^{\frac{1}{2}}$ and $(p_a)^{\frac{1}{2}}$, and are designated Scales A and B, respectively. $A = (h)^{\frac{1}{2}}$, and is identified by the differential, and $B = 1/(p_a)^{\frac{1}{2}}$, and is identified by the static in lb. per sq. in. gage.

The chart is designed for a reading arm pivoted at zero at the lower left-hand corner of the chart. The hair line in the center of this arm permits fast and accurate reading.

For brevity, convenience and clarity, letters are assigned to the other scales. Definitions of letters are as follows:

C = meter coefficient,
D = pressure extension for 24 hr.,
E = pressure extension for 1 hr.,
F = volume of gas per hr.,
G = size of orifice, and
L = center line of arm.

Values of scales are as follows:
C depends upon F, and vice versa,
D is read as hundreds.



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E is read as tens,
G depends upon the meter coefficient, and size of meter run.

Meter runs: 4-in. has columns for coefficients of 2, 3, and 4 figures; that is, coefficients reading as tens, hundreds, and thousands; 6-in. has same; 8-in. has also a tens of thousands column.

● **Operation.** When L is placed on the intersection of A and B, A is divided by B. The quotient A/B is read on the E Scale where L crosses the "10" horizontal line, and is the hourly pressure extension. The 24-hr. pressure extension is read where L crosses the D scale. With L at the intersection of A and B, the vertical line representing F, or quantity, will touch L at the horizontal line representing C, or the meter coefficient. The value of F will determine the value of C, and the value of C is the guide to the column in meter run section in which will be found G, or size of orifice.

● **Problems.** (Refer to illustrations).

**PROBLEM NO. 2**

**PRESSURE EXTENSION CHART FOR ORIFICE METERS**

**Based on Atmospheric Pressure of 13 lb. per sq. in.**

## INSTRUCTIONS

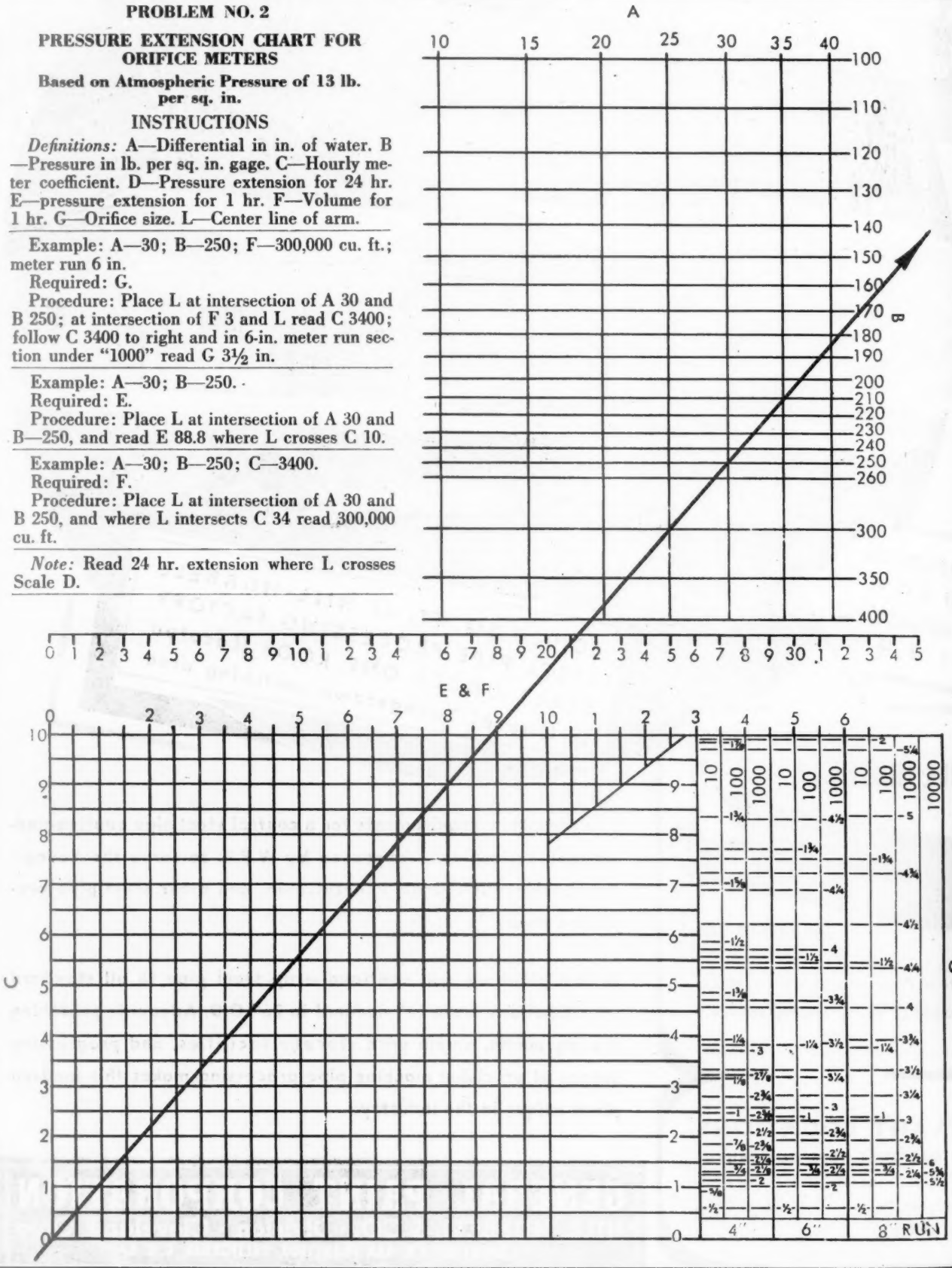
*Definitions:* A—Differential in in. of water. B—Pressure in lb. per sq. in. gage. C—Hourly meter coefficient. D—Pressure extension for 24 hr. E—pressure extension for 1 hr. F—Volume for 1 hr. G—Orifice size. L—Center line of arm.

Example: A—30; B—250; F—300,000 cu. ft.; meter run 6 in.
Required: G.
Procedure: Place L at intersection of A 30 and B 250; at intersection of F 3 and L read C 3400; follow C 3400 to right and in 6-in. meter run section under "1000" read G 3½ in.

Example: A—30; B—250.
Required: E.
Procedure: Place L at intersection of A 30 and B—250, and read E 88.8 where L crosses C 10.

Example: A—30; B—250; C—3400.
Required: F.
Procedure: Place L at intersection of A 30 and B 250, and where L intersects C 34 read 300,000 cu. ft.

*Note:* Read 24 hr. extension where L crosses Scale D.

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2½ diameters upstream and 8 diameters downstream.
P B 16.4 lb. Base and flowing temperature 60 °F. Gravity .600.

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2½ diameters upstream and 8 diameters downstream. P B 16.4 lb. Base and flowing temperature 60 °F. Gravity .600.

No. 1. Differential = 30-in.; static = 250 lb. per sq. in. gage; F = 300,000 cu. ft. Meter run is 6 in.

Required: Size of orifice.

Procedure: Place L at intersection of A 30 and B 250, follow F 3 to L and read C 3.4, which intersects F 3 at L. As the value of F is in hundreds of thousands, the value of C will be in thousands.

(300,000/88.8 = 3400—). Follow C 34 to the right to 6-in. meter run section. As C is in thousands, the size of orifice will be found in the "1000" column. It will be noted that, to be able to deliver 300,000 cu. ft. of gas per hr., a 3½-in. orifice is needed. Orifice sizes are based on pipe tap connections.

No. 2. Differential = 30 in.; static = 250 lb. per sq. in. gage.

Required: Hourly pressure extension.

Procedure: Place L at intersection of A 30 and B 250. Where L crosses the "10" horizontal line, read E 8.88. As E is read as tens, the pressure extension is 88.8. If the 24-hr. pressure extension is desired, note where L crosses D. This reading is 21.3, and since D is read as hundreds, the pressure extension is 2130.

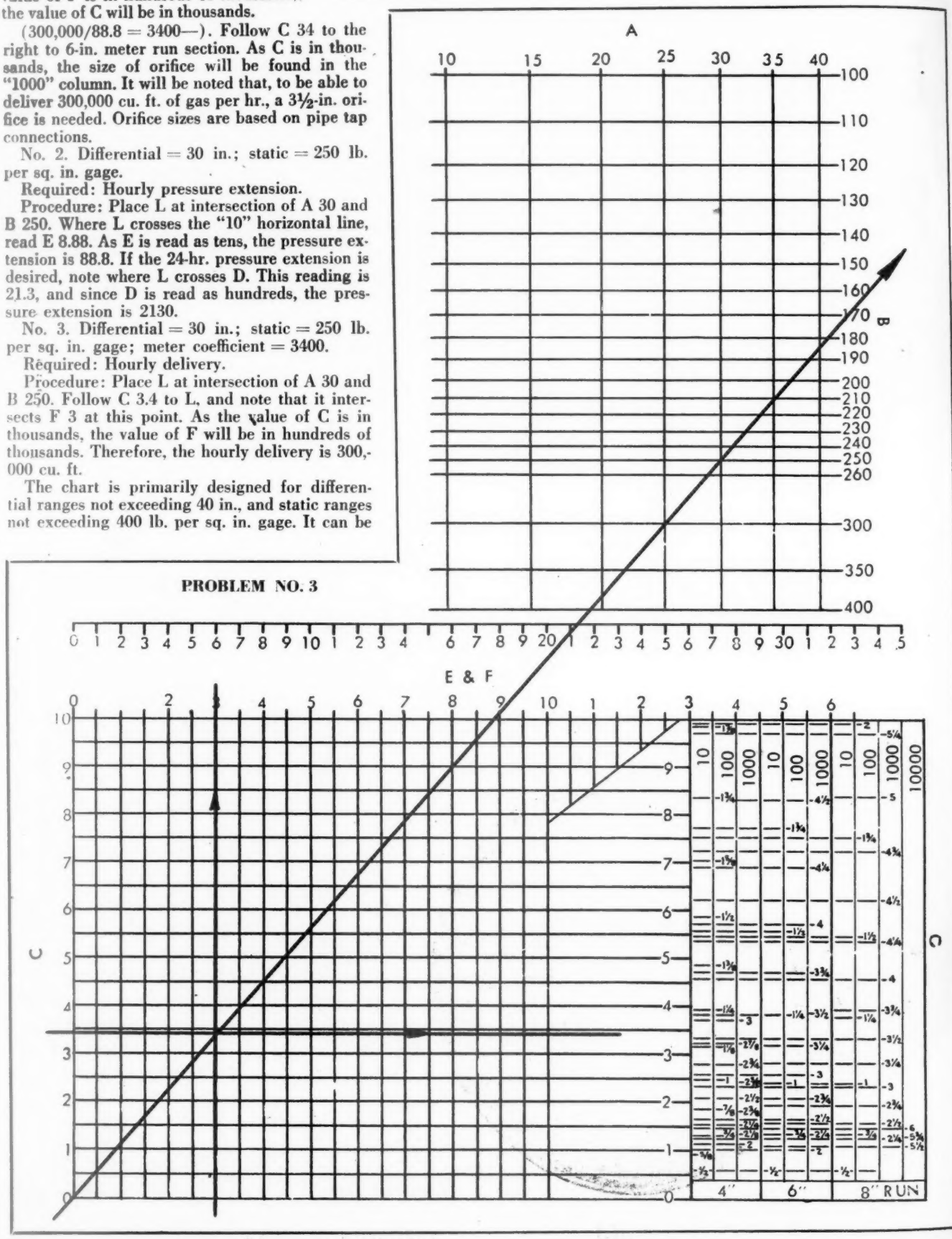
No. 3. Differential = 30 in.; static = 250 lb. per sq. in. gage; meter coefficient = 3400.

Required: Hourly delivery.

Procedure: Place L at intersection of A 30 and B 250. Follow C 3.4 to L, and note that it intersects F 3 at this point. As the value of C is in thousands, the value of F will be in hundreds of thousands. Therefore, the hourly delivery is 300,000 cu. ft.

The chart is primarily designed for differential ranges not exceeding 40 in., and static ranges not exceeding 400 lb. per sq. in. gage. It can be adapted to greater ranges, however. In order to show this adaptation, sketches have been traced from the chart. These sketches contain only enough lines to illustrate the adaptation.

Referring to Sketch A, it will be noted that it illustrates the use of the chart for meters having a differential range of 50 in. and a static range of 1000 lb. A differential of 30 in. and static of 250 lb. gage have been chosen for the illustration. Let the static of 250 lb. represent half of the static reading. $E_1$ represents a permanent line, or an additional scale. $E_2$ represents the 50 per cent horizontal line. When half the static reading is



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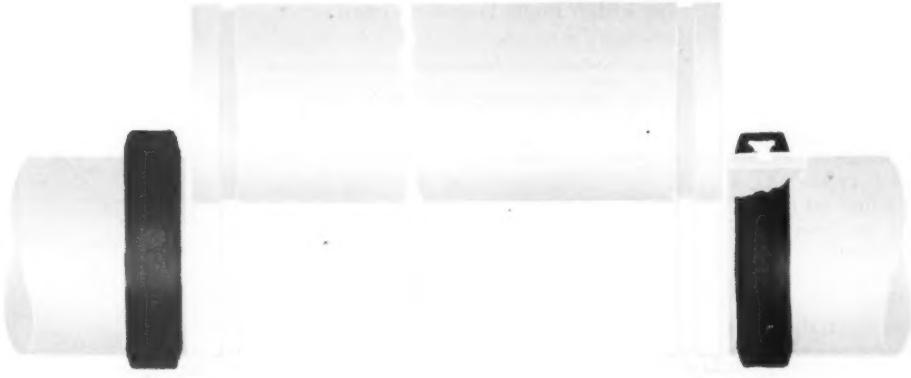

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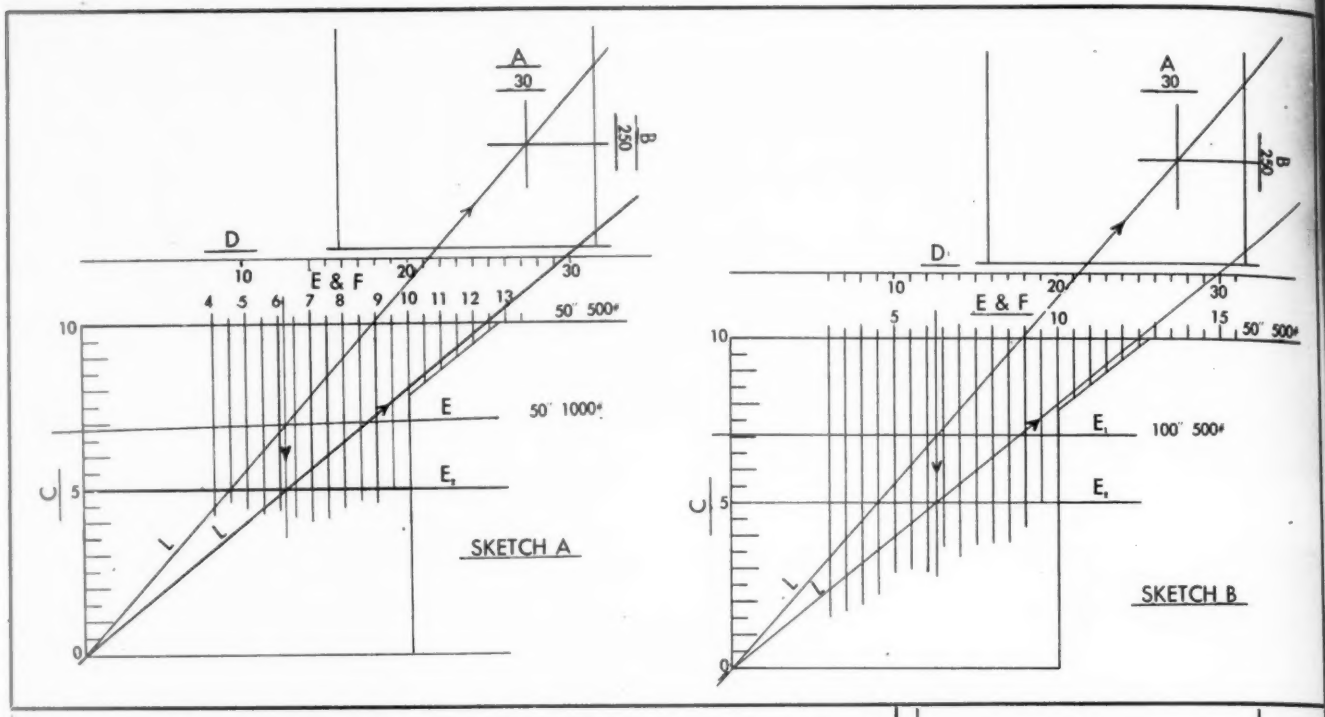



used for computation, a reading is taken where L crosses $E_1$, L is moved to this reading on $E_2$, and the pressure extension is read on the E scale where L crosses the "10" horizontal line, and the 24-hr. extension is read where L crosses the D scale.

Referring to Sketch B, it will be noted that it illustrates the use of the chart for meters having a differential range of 100 in. and a static range of 500 lb.

Half the differential reading will be used in making the computation. A reading will be taken where L crosses $E_1$, L will be moved to this reading on $E_2$, and pressure extension will be read on E where L crosses the "10" horizontal line. The 24-hr. extensions will be where L crosses the D scale.

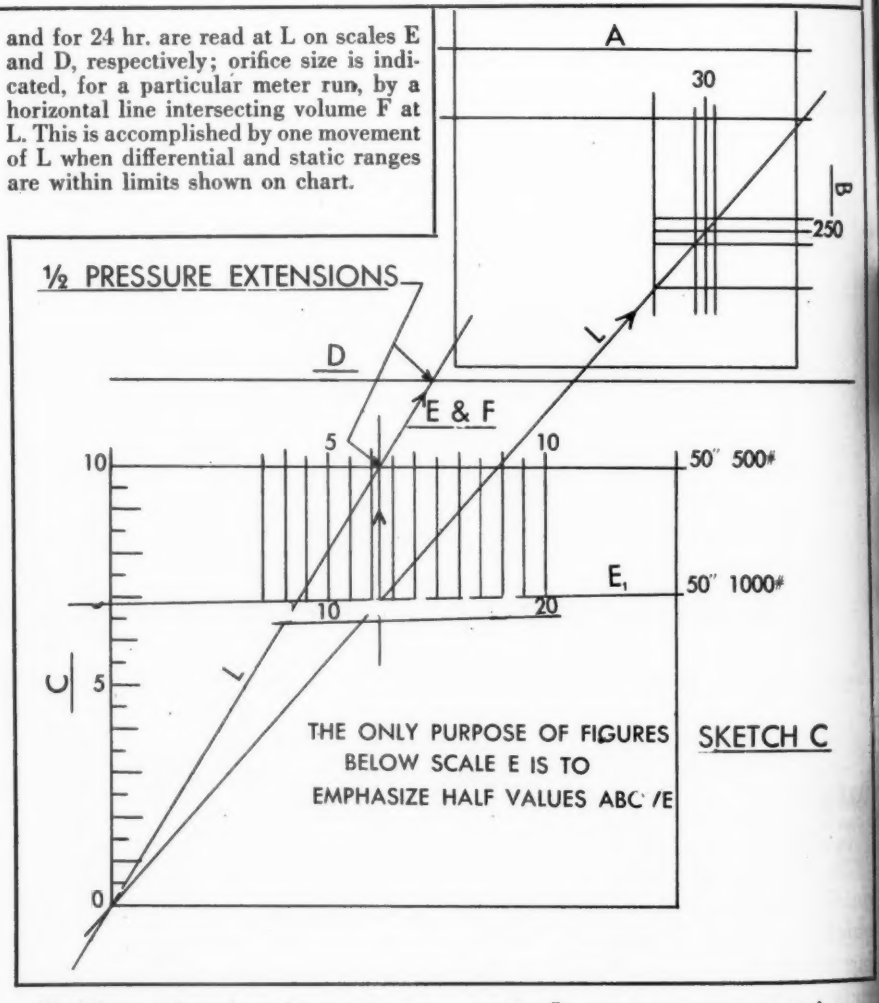
One additional line drawn on the chart will adapt it to any differential and static combination desired. The points for this line are established as follows:

Differential limits are from 10 to 40 in.; static limits are from 100 to 400 lb. Draw a line from zero to the intersection of A 10 and B 100, and another line from zero to the intersection of A 40 and B 400. For example, take Sketch A, where static is doubled. The first point is $\frac{1}{2}(213/113)^{\frac{1}{2}}$ and is placed on the line from zero to the intersection of A 10 and B 100. The second point is $\frac{1}{2}(813/413)^{\frac{1}{2}}$ and is placed on the line from zero to the intersection of A 40 and B 400. Place a straightedge on these points and draw a line. Make the readings as shown in Sketch A.

Where there is only a change in the differential, the line is horizontal. Its point is $\frac{1}{2}(h_1/h)^{\frac{1}{2}}$ where $h_1$ = the changed differential.

Where there are changes in both differential and static, the points are established as follows: $\frac{1}{2}[(h_1/h)(p_{s1}/p_s)]^{\frac{1}{2}}$, where $P_{s1}$ = the changed static.

To sum up: When L is at intersection of A and B, coefficient C intersects volume F at L; pressure extensions for 1 hr. and for 24 hr. are read at L on scales E and D, respectively; orifice size is indicated, for a particular meter run, by a horizontal line intersecting volume F at L. This is accomplished by one movement of L when differential and static ranges are within limits shown on chart.




If differential and static ranges are beyond the limits shown, use a special line (Sketches A and B) for an initial reading at L, transfer L to this reading on the 50 per cent horizontal line, and read pressure extensions on their respective scales. With L on correct pressure extension, it is the same as if L were at the intersection of actual differential and static. In event pressure extension exceeds the scope of scales E and D, take the reading at $E_1$, and move L to this reading on the 100 per cent horizontal line. (Sketch C). With L in this position, E and D readings are pressure extensions/2. Any computation, under these conditions, requires no more than two movements of L. ★★★

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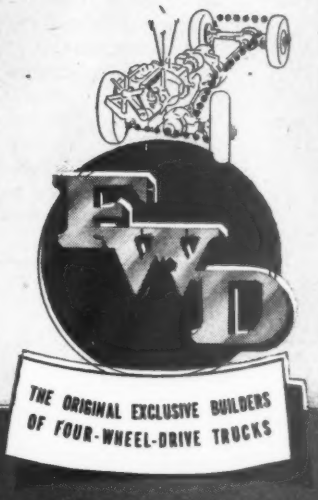


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# SALT WATER DISPOSAL IN EAST TEXAS

VOCATIONAL CLASS PROCEEDINGS

## INSTALLMENT NO. 10

EXCLUSIVE ● *Filters.* Filters are the last and one of the most important parts of the treatment of salt water. Nearly all the filters employed in the treatment of salt water use sand as a filter media. These filters deliver uniformly clear water, free from suspended matter, particularly iron oxide. If the water is perfectly clear, without any suspended matter, is stable with respect to carbonates, contains 0.5 PPM of chlorine, and not more than 0.1 PPM of iron, it is ready for injection into the well.

There are two types of filters being used in the East Texas field. One is the rapid sand filter and the other is the slow sand filter.

The one most generally used is the rapid sand filter. There are three kinds of rapid sand filters: One, and the most important, is the closed steel tank; the second is the open steel tank, and the third is the open concrete tank with aloxite plates.

The closed steel tank is by far the most universally used in the field. (See Fig. 61.) These tanks are usually 8 ft. in diameter with just a little over 50 sq. ft. of sand area. The filter shells usually use heads of approximately the same radius as the diameter of the tank. These heads are approximately 3/8 in. thick. The rest of the filter is 5/16 in. thick. The overall height of the filters is of secondary importance, as long as there is room for an upper and lower header, 3 ft. of filter sand and gravel, and a few inches of open free board for expansion of the sand during backwashing. The filter sand and gravel is usually referred to as a charge.

The inlet header, which may enter the tank either from the side or the top of the shell spreads out from one 6-in. opening to eight 2-in. openings with these openings being pointed upward. These headers are well supported in the shells.

The lower header or effluent header is connected with a 6-in. outlet. The 6-in. pipe runs the entire width of the tank; thirty 2-in. laterals then cover the tank. The 2-in. laterals in turn have cast iron nozzles attached to them. Each nozzle has three 1/8-in. holes and there are approximately 180 nozzles in each 8 ft. diameter filter. The nozzles may be either above or below the headers, but in any case the holes in each nozzle point down. The nozzles are usually turned down to facilitate the cleaning operations and the removal of the filter charge.

The bottom layer in each filter is usually a layer of ordinary gravel. (See illustration.) This has been placed here to hold the 4-in. cement layer above. The 4-in. cement layer is placed in the bottom of each shell to eliminate as much of the dead space in the filter as possible. This 4-in. layer of concrete is poured to within an inch and a half of the nozzles.

The next layer used is 1¼-in. by ¾-in. gravel and is 3-in. thick. Then comes a layer of ¾-in. by ½-in. gravel and then a layer of ½-in. by ¼-in. gravel and then a layer of ¼-in. by ⅛-in. gravel. On top of all of this is placed a 24-in. layer of filter sand. This sand has been thoroughly washed and cleaned. The size of the granules ranges from .40 mm. to .48 mm. Sharp jagged sand is preferred to round sand. The coefficient of uniformity of the sand should not exceed 1.6. Each layer of sand and gravel must be very evenly placed in the filter.

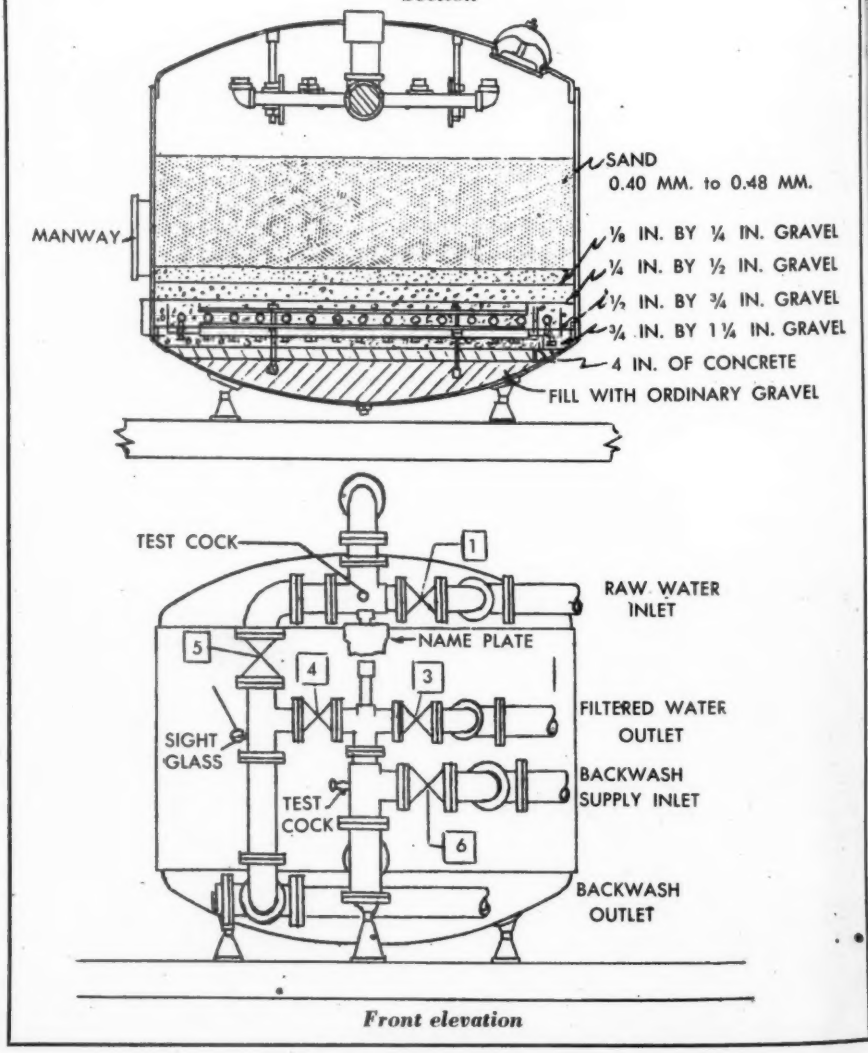
There are usually five connections to each filter. They are: Influent raw water, effluent filtered water, influent backwash water, effluent backwash water, and settling line. The size of the valves and lines must be determined by the available heads and the volume of water to be handled.

Backwash lines on the newest design have 5-in. valves. The influent raw water and effluent filtered water lines have 4-in. valves. The settling line has a 3-in. valve. These valves are of the lubricated plug type and are made of cast iron. Some gate valves are used.

The filter rate through the filters may run as high as 3 gal. per sq. ft. per min. or about 150 gal. per min. The quality of the raw water coming to the filter will make a considerable difference in the amount of water a filter can handle. Turbid water will require a much slower rate of filtration.

The filter charge will have to be changed from time to time because of the accumulation of oil, bacteria, iron oxide, and calcium carbonate in the sand. These four foreign substances tend to cement the sand together and prevent the proper expansion and grinding ac-

FIG. 61.
*Section*

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tion when the filter is being backwashed.

The sludge or sediment during operation collects on the top of the sand to a depth of approximately ⅛-in. to 3/16-in. before it becomes necessary to backwash the filters. The length of periods between backwashing is dependent upon the accumulation on top of the sand and the amount of head available. The backwash rate for a sand filter is recommended at between 12 and 15 gal. per sq. ft. per min. or from 600 to 750 gal. per min. for each 8-ft. diameter filter. This rate is designed to give the maximum expansion of the bed without carrying sand over with the backwash water.

This expansion of the bed and the grinding action that occurs will remove most of the sludge and mudballs and fine sand in the filter. However, it will not remove all the oil, and calcium carbonate deposits. When the bed is cemented together so that the backwash water will not expand the bed, something must be done. Usually one carboy of 20 per cent hydrochloric acid to one filter will remove most of the bonding agent. This acid job may allow the use of the charge for three additional months. If the cementation becomes too bad the charge should be removed and a new one installed.

The backwash head may be obtained from a pump and a clear tank or by use of an elevated tank. Experience in this field shows that approximately 100 bbl. per backwash will clean one filter if the filter is in good condition. As a safety factor, usually 200 bbl. of water are provided for backwashing.

In this type of filter the head required for a thorough backwash is about 35 TDH at the influent valve of the filter. Any restriction other than that of the filters and valves must be provided for.

It is not economically feasible or good engineering practice to connect more than 4 filters in line. The filters are usually set about one foot apart and connected by means of a header. Each filter should have a reinforced concrete pad about 8 in. thick and 9 ft. by 12 ft. to support the filter jacks. An 8-in. diameter filter weighs approximately 40,000 lb. when in service.

Open tank filters are made in much the same manner as closed tank filters. The advantage of closed tank filters is in the amount of head that may be impressed across the face of the sand. If a filter operates at 20 lb. pressure, about 85 per cent of the sludge will be retained at the surface of the sand. With 10 per cent retained in the first inch of the sand the remaining 5 per cent may go as low as 6 in. in the sand.

The biggest advantage of an open tank is that the condition of the filter may be easily seen and close examination made. The head available across the filter charge is limited to the height of the tank, usually from 3 ft. to 6 ft.

A concrete filter with aloxite carborundum plates is also in use in the field. This filter is made of poured concrete. The usual bottom header is replaced by the aloxite plates. The 24-in. filter sand is then placed directly over the plates without the use of gravel. The main advantage of this filter is that the influent raw water may settle directly on the sand without disturbing the floc by its passage through a pump or a pipe.

Whenever it is possible, arrangements should be made to prevent the use of a pump or a small line between the settling basin and the filters. The finer the floc, the more work the filters will be required to do. (See sketch of concrete filter.)

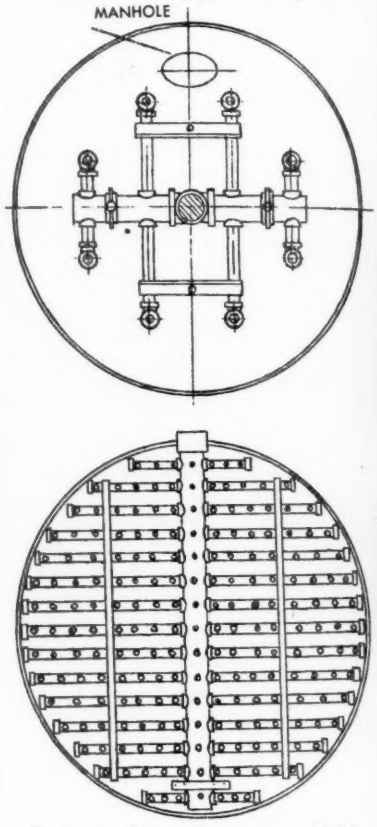
The disadvantage of open concrete filters lies in the trouble with the aloxite plates. Oil, iron oxide, bacteria, and calcium carbonate will plug them in the same manner as a normal sand and gravel charge. A concrete filter is much harder to operate than an iron tank because of the methods of connecting all the piping.

A slow filter differs in design from a rapid filter by the fact that it is never backwashed. A slow filter is usually large enough to operate at about 1/10 gal. per min. per sq. ft. Slow filter areas are usually measured in acres. Several types of lower headers are used, the principal one being a slotted tile laid in the bottom of the filter to collect the filtered water. The gravel bed, usually of the same specifications as a rapid filter, is placed on the tile. Then from 30 in. to 36 in. of filter sand is placed on top of that.

When the sand becomes too plugged for the desired amount of water to flow

**FIG. 62.**

Top view—*Upper manifold.*




Bottom view—*Lower manifold.*

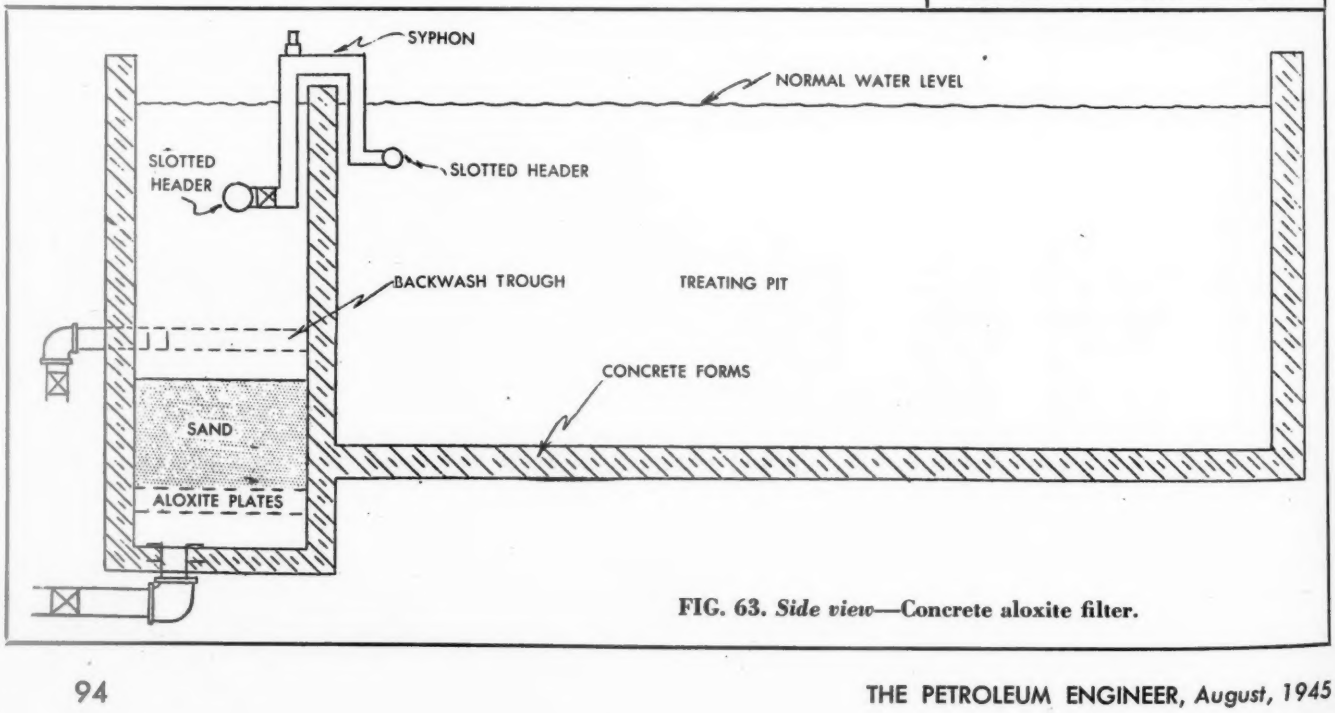



**FIG. 63.** *Side view*—Concrete aloxite filter.

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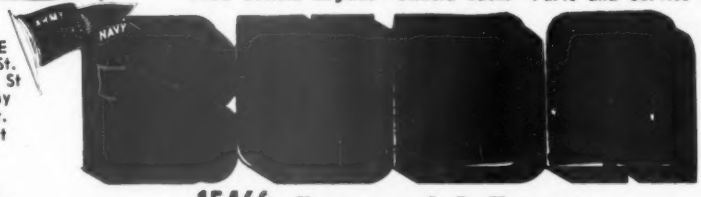


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through, workmen drain the filter and then go into the filter. They remove the top 2 in. of sand with square pointed shovels. The filter is then placed back in service. This is the reason that 30 in. to 36 in. of sand is placed in the filter. It is felt that the sand can be scooped up in layers of 2 in. until only 16 in. of sand remains.

There is not sufficient data on hand at present to make a comparison between the rapid and slow types of sand filters for salt water. The initial cost of the slow type filter, however, is very great in comparison to the 8-ft. diameter rapid filter. It is also felt that the cost of replacing such large amounts of sand and gravel will be high.

The quality of water from the slow filter will be better at first and then gradually get worse. The slow rate of flow may permit oil and bacteria to form iron sulphide in the sand. The calcium carbonate may also cement the gravel and sand together. But it, by itself, would not do any harm.

Possible improvements for filters include the use of Anthrafilt as a filter media. Anthrafilt is ground and washed anthracite coal graded to similar sizes as sand and gravel specifications. Crushed coal gives a very jagged shape to each granule. It is considerably lighter than sand, about one-half, and consequently its grinding action during backwashing will be much greater.

At present, the coal must be obtained from Pennsylvania. The freight rate is about $1.83 per 100 lb. If water rates can materially reduce the cost of transportation after the war, Anthrafilt may displace sand as a filter media.

Plastic nozzles and plastic pipe may also be used at some future date. This will depend upon the cost of production.

Cathodic protection of the iron filter and connections is also being considered. A cathodic protection unit is now in experimental operation. If this is successful, it will be possible to install these units in pressure filters.

Meanwhile several filters have been coated with various substances, lead paint and bitumastic being the most prominent of these. An air-dried vinyl

*(Continued on Page 100)*

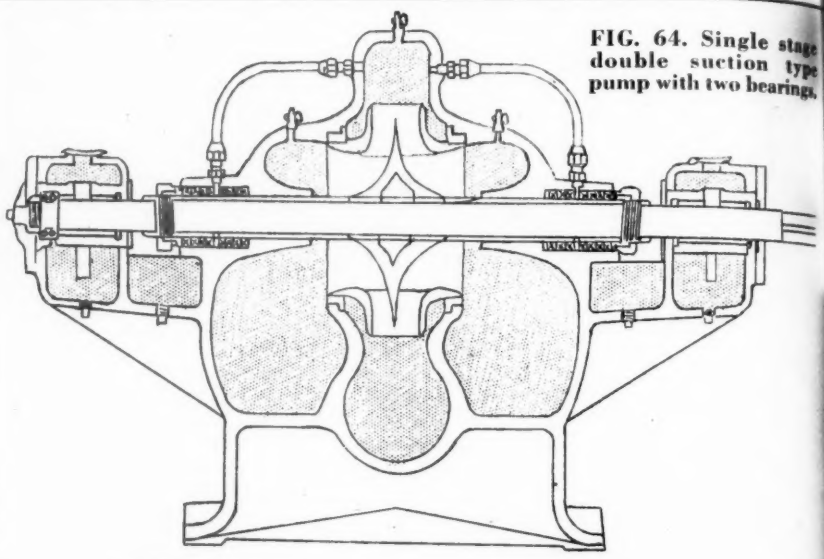

FIG. 64. Single stage double suction type pump with two bearings.

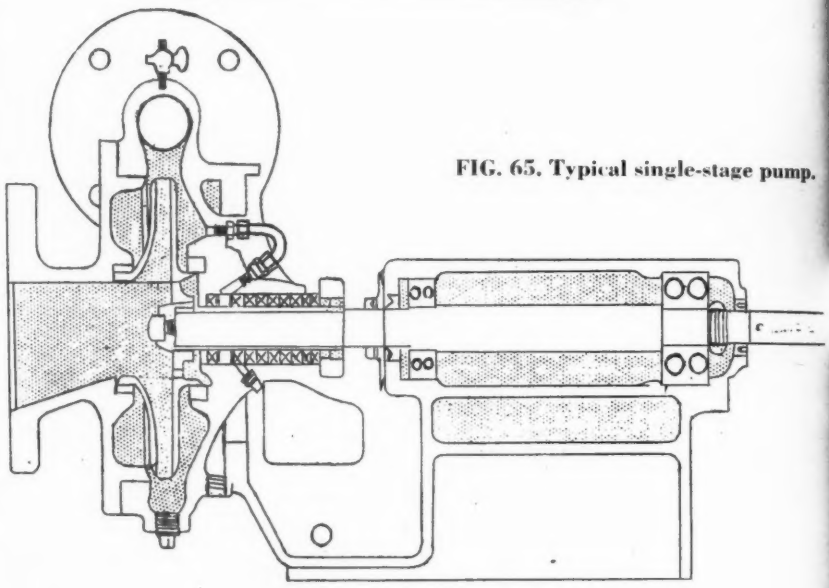

FIG. 65. Typical single-stage pump.

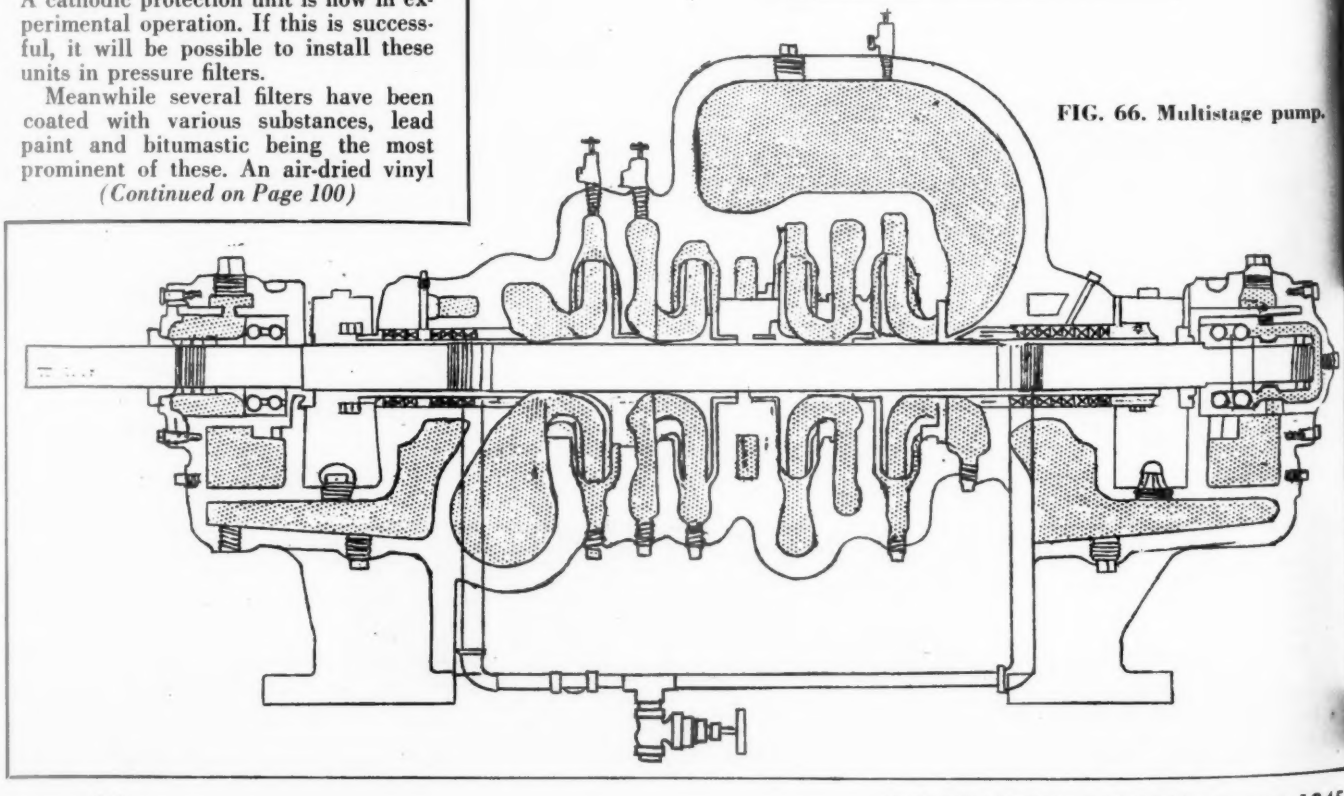

FIG. 66. Multistage pump.

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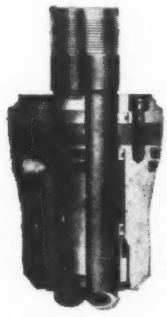
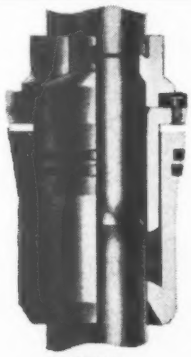


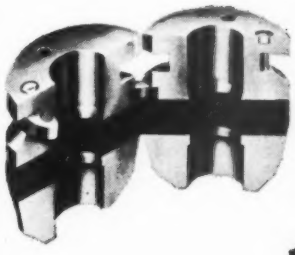
**AFB-3**

Polish Joint Type which incorporates an additional means of sealing with tubing head lock screws.



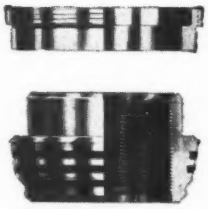
**ASTM**

Permits running and landing of tubing through assembled christmas tree. This hanger is designed to permit any method of well completion.



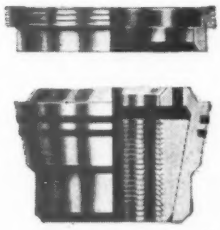
**ALK**

Used in completions where a polish joint hanger would otherwise be applied, this hanger eliminates the polish joint, since a seal can be effected on any joint of tubing. It can also be used as a blowout preventer.



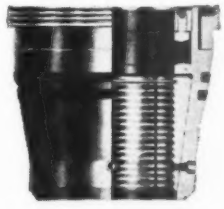
**LHCH**

Threaded mandrel hanger permits landing of casing through preventers and is satisfactory where close spacing of pipe is not necessary.



**LHCLWS**

The LHCLWS Casing Hanger utilizes slips for suspension and welded seal. Slips are assembled inside housing and complete assembly may be landed through blow-out preventers.



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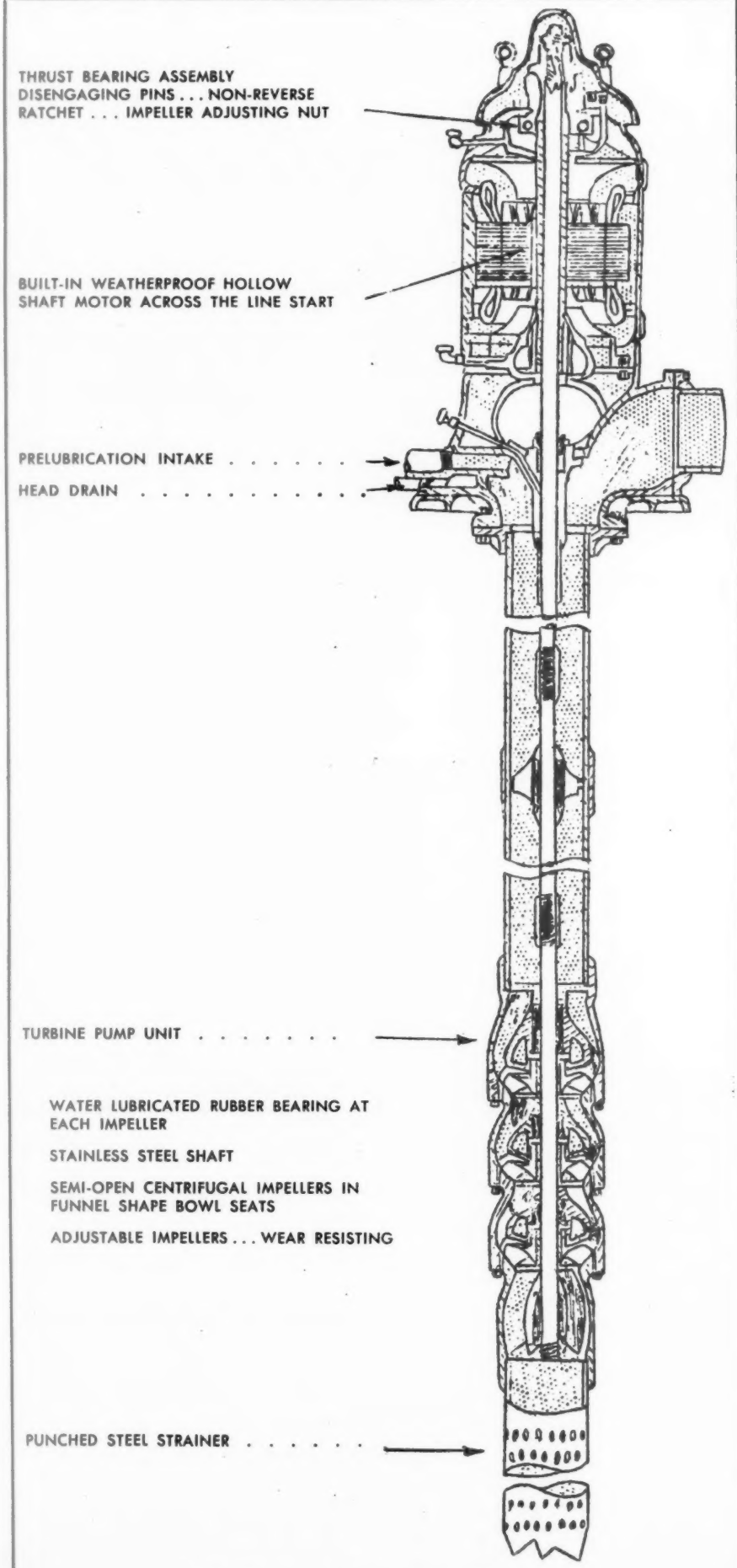
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EACH IMPELLER
STAINLESS STEEL SHAFT
SEMI-OPEN CENTRIFUGAL IMPELLERS IN
FUNNEL SHAPE BOWL SEATS
ADJUSTABLE IMPELLERS . . . WEAR RESISTING
PUNCHED STEEL STRAINER . . . . . .

**FIG. 67. Deep well electric turbine pump.**

*(Continued from Page 96)*

resin coating is also being tried. The lead base paint has not been very successful.

## PUMPS

● **Centrifugal pumps.** There are many types of equipment with which water may be raised or pumped. In some cases unusual conditions of pumping require certain specific types of equipment. In most cases, however, it will be found that the centrifugal pump is the most suitable from all standpoints. (See Table 3 on operating characteristics of the various types of equipment.) Despite the popularity of the centrifugal pumps many are not entirely acquainted with its operating characteristics.

A centrifugal pump consists of an impeller or rotor with an intake at the center, so arranged that when rotated it will discharge water or other liquids by centrifugal force into a casing that surrounds the impeller. The pressure developed by the pump is entirely the result of the velocity imparted to the water or liquid by the impeller and is not due to any impact or displacement.

A single-stage pump is one that has only one impeller. A multistage pump is one that has two or more impellers in a single casing, one impeller discharging into the next, and so on. A single suction pump is one that admits water on only one side of the impeller, whereas a double suction pump admits water on both sides of the impeller. The pressure developed by a centrifugal pump is entirely dependent upon the speed at which it operates and the size of the impeller. If the speed of any pump is doubled, the head will be increased to four times the original head.

Double-suction pumps have one inherent disadvantage. This is the distance between bearings. This length is usually so great that any unbalance from the wear on the impeller will cause considerable vibration and crystallize the impeller shaft. This is particularly true of pumps operating at speeds of 3600 r.p.m. Another disadvantage of double-suction pumps is the initial cost. These pumps usually cost four times that of the single-suction, single-stage units. The double packing gland on this unit means that the operator will have two packing glands to care for (Fig. 64).

Single stage-single suction pumps are perhaps the best type of pump to use provided they can fill the head and volume requirements. In this pump the suction opens directly to the impeller eye. The impeller may be an open or closed type. The pump usually has one packing gland with two ball bearings supporting the shaft. This pump has many advantages. It is economical to purchase, it has only one packing gland, its bearings are so placed to carry all the impeller load, and the shaft is heavy enough to be driven safely up to rated speed. Some pumps are recommended for speeds up to 3600 r.p.m. These variable speeds give varied selections with respect to range and volumes (Fig. 65).

Multistage pumps are not generally suitable for salt water pumping. Two-stage pumps at 1750 r.p.m. do fairly

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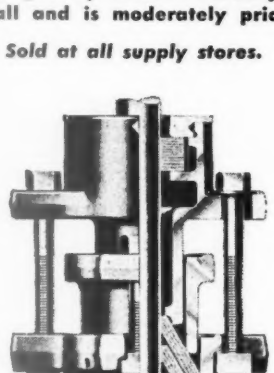

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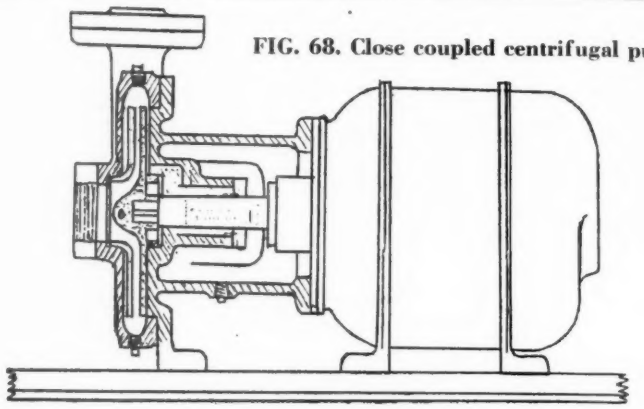


**FIG. 68. Close coupled centrifugal pump.**

**TABLE 3**
**Operating characteristics of various types of pumps.**

| | Centrifugal | Rotary | Reciprocating | | |
|---|---|---|---|---|---|
| | | | Triplex | Double-acting power | Direct-acting steam |
| Flow | Even | Even | Pulsating | Pulsating | Pulsating |
| Effect of increasing head— | | | | | |
| Capacity | Decrease | None | None | None | Decrease |
| Power | Decrease | Increase | Increase | Increase | Increase |
| Effect of decreasing head— | | | | | |
| Capacity | Increase | None | None | None | Slight increase |
| Power | Increase | Decrease | Decrease | Decrease | Decrease |
| Effect of shutting discharge valve: Increase pressure | 15 to 30 per cent | Pressure increases with violently destructive effect if no relief valve is used | | | Increase |
| Power | Decrease 50 to 60% | Power increase to destruction | | | Increase |
| Valves | None | None | Inlet and discharge valves | | |

well, but the corrosive fluid affects the wearing rings between stages and soon causes an unbalance. This causes the shaft to crystalize and break. Four-stage pumps have a fluid lubricated bearing between impellers. This soon becomes corroded and the life of the pump is materially shortened. Multistaged pumps are high priced. Repairs that are made require a skilled mechanic.

Deepwell turbine pumps are used to a limited degree for salt water disposal work. These units are usually a multistage pump in a vertical position. There is a decided advantage to a deep turbine type pump in that the suction of the pump is always primed. The long distances between bearings, and bearings that also have to be lubricated with salt water, however, are a disadvantage (Fig. 67).

Close-coupled pumps have the same application as the units offered in double-suction and single-stage pumps. This type of design is finding increasing favor because of its comparatively low cost, compactness, and ease of installation. At high speeds there cannot be any coupling trouble, because the pump is mounted directly on the motor (Fig. 68).

A centrifugal pump differs from other types of pumps in that its impeller can be whirled freely even though the discharge valve is closed. The reason for this is that the head or pressure developed by the pump is entirely the result of the velocity imparted to the water by the whirling impeller. The effect of imparting velocity to the water will be better understood by considering what happens to falling water. When water or other material falls from any given height, its velocity may be expressed as follows:

$V^2 = 2\ GH$

Where:

G = acceleration of gravity (32.2 ft. per sec. per sec.)

H = the head in feet from which the mass has fallen.

Now, if we consider water falling from a height of 100 ft., the velocity at the bottom of the fall will be:

$V^2 = 2 \times 32.2 \times 100$ ft., or 6440 ft. per sec.

V = 80.3 ft. per sec., or 4818 ft. per min.

If we wish to return the water to the point from which it has fallen, this can be done by starting the water upward at the same velocity as the water had when it reached the ground.

Therefore, if our centrifugal pump impeller is rotating in a pump casing so that the speed of the impeller periphery is more than 80 ft. per sec., the pump can be expected to discharge water against a head of 100 ft.

The purpose of the casing around the impeller is to convert the water velocity into pressure. The effectiveness of this conversion, together with the friction in the bearing, losses at the impeller eye, or inlet, etc., determines the pump efficiency or the ratio between the useful work done by the pump and the power delivered by the pump shaft. ★★★

**(Installment No. 11 will be published in an early issue.)**

# AIR-LIFT RESEARCH PROJECT OF THE A & M COLLEGE OF TEXAS

By **S. F. SHAW,** *Gas-Lift Specialist*

***Air-lift experiments determine quickly the maximum capacities of flow pipes for both oil and water.***

**EXCLUSIVE** An air-lift research project was instituted at the A. & M. College of Texas in 1942 for the purpose of determining the maximum capacities of pipes of 1-in., 1½-in., 2-in., and 2½-in. diam. for both water and oil, with lengths of pipe ranging from 11 to 80 ft. Experiments with approximately 11 ft. of pipe were conducted in the gas laboratory; those with greater lengths were carried out in a derrick in the field laboratory of the Petroleum Engineering Department.

The purpose was to determine, so far as practicable, the maximum capacities of these flow pipes for both oil and water, and, if possible, to derive a factor that would permit the conversion of capacities of water to those of oil, using water as a standard. The facilities of the college did not permit using pipes of greater diameter than 2½ in., or lengths greater than 80 ft., but it was hoped that experiments under these conditions would develop trends of such nature that they would point the way toward a means of determining capacities for much larger diameters and for lengths ranging up to 5000 ft. or even 10,000 ft. The tests were sufficient to indicate that with adequate facilities experiments could be made that would determine the capacities of flow pipes under any and all conditions, as well as the quantity of compressed air or gas required to lift a unit quantity of liquid under these conditions. Extension of the project should consist of carrying on the tests in wells to depths of 5000 ft. or more, in which completions were made with casing of 9⅝ in. or even larger, and where there is available an adequate quantity of gas from a gas well, or from a compressor plant, at the pressures necessary to handle submergences of 30 per cent or more.

In an article of this nature, space is not available to present all the data obtained in the tests that were made at the A. & M. College, therefore, only the highlights will be given. It is expected, however, that complete data will be made available in a bulletin to be published by the Engineering Experiment Station.

The experiments were made for the purpose of providing data for methods of operating oil wells by gas-lift when lifting oil or salt water. It is seldom that submergences of 30 to 40 per cent are exceeded in gas-lift work in wells that produce pipe-line oil, for at greater submergence than 40 per cent the oil usually contains sufficient gas in solution to enable the wells to produce on natural flow. Moreover, in deep wells, particularly those producing salt water with the oil, a submergence greater than 30 per cent usually involves the use of gas under pressure that is higher than is practicable to use. Consequently, most tests were made with submergences of 10, 20, and 30 per cent. Tests were made with 11-ft. lengths of 1-in. and 1½-in. pipe, however, with submergence up to 70 per cent in order to determine the trend of capacity and of lifting efficiency when employing very high submergence.

Diameters and lengths of pipe employed in the experiments were:

1-in.—10.8 ft., 24.5 ft., 42.4 ft. and 73 ft., lifting water.

1-in.—27.6 ft. and 78.8 ft., lifting oil.

1½-in.—10.9 ft., 22.3 ft., 42.5, and 72.7 ft., lifting water.

1½-in.—27.5 ft. and 78.8 ft., lifting oil.

2-in.—22 ft., 42.2 ft., and 72.7 ft., lifting water.

2-in.—26.8 ft., and 79.1 ft., lifting oil.

2½-in.—27 ft. and 72.8 ft., lifting water.

2½-in.—27.2 ft. and 79.8 ft., lifting oil.

● **Effect on capacity of increasing submergence.** The effect on capacity of increasing the submergence is shown in Fig. 1. A set of tests was made to determine the maximum capacity of 1½-in. pipe, 10.9 ft. in length with submergence ranging from 26 to 74 per cent. The quantity of air required to lift a barrel of water was also determined as closely as possible under the conditions, and from the data so obtained the lifting efficiency was computed, the actual useful lift being considered as the distance from the level of the water to the point at which it is discharged at the top of the pipe. In all cases there was a free discharge, with no back pressure applied, consequently the efficiencies so computed, based on the energy of compression stored in the air, are at their maximum. Data applying to the tests are shown in Table 1.

The data in Table 1 indicate that as submergence is increased for a given length and diameter, the capacity is in-

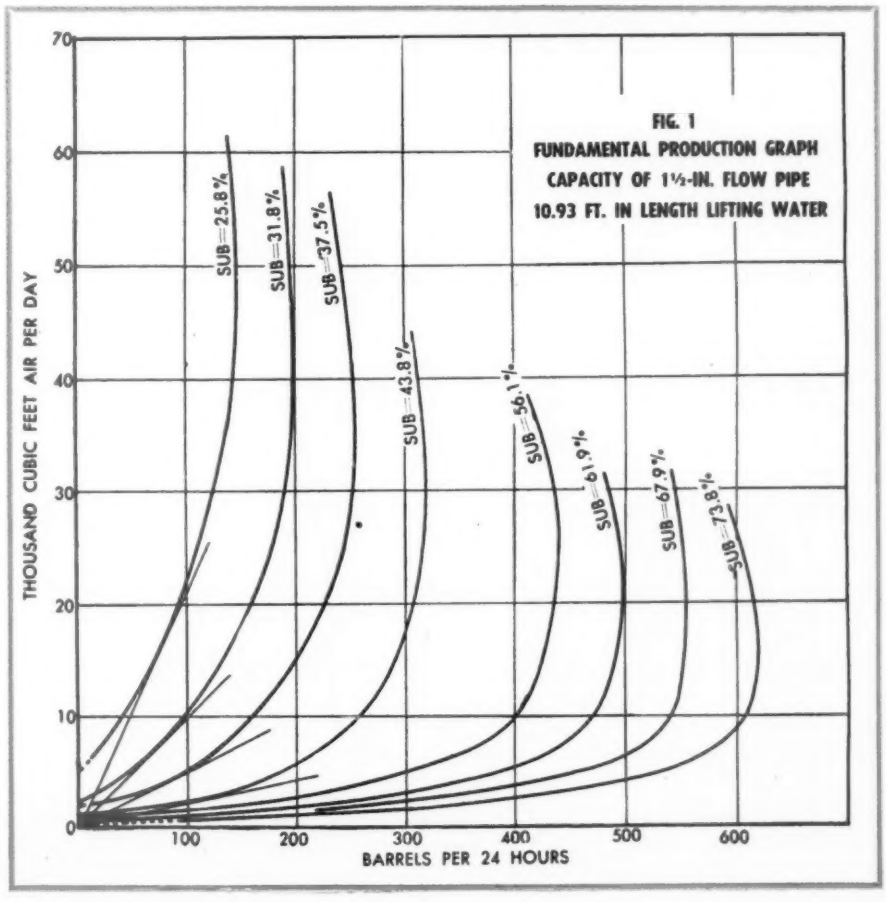


**TABLE 1**

**Data on capacities and efficiencies of 1½-in. pipe, 10.9 ft. in length.**

| Per cent submergence | Bbl. water per day | Cu. ft. air per bbl. | Per cent lifting efficiency |
|---|---|---|---|
| 25.6 | 148 | 295 | 5.7 |
| 31.3 | 202 | 213 | 6.7 |
| 36.1 | 258 | 129 | 8.0 |
| 42.6 | 320 | 90 | 9.1 |
| 53.0 | 440 | 43 | 12.4 |
| 57.3 | 498 | 43 | 10.4 |
| 61.5 | 554 | 23 | 16.4 |
| 65.2 | 618 | 21 | 16.0 |

creased. This effect was checked by tests made with 1-in. pipe and the same trend was observed. Also, as submergence was increased up to perhaps 65 per cent, the lifting efficiency was increased, but beyond submergence of about 65 per cent the lifting efficiency appears gradually to have become reduced.

The maximum capacity of a 1½-in. pipe 11 ft. in length with submergence of 26 per cent is about 150 bbl. a day. With submergence increased to 74 per cent the capacity is about 620 bbl. a day. It may be noted that the total quantity of air required to lift 620 bbl. a day at 65 per cent submergence is only about one-third that required to lift 150 bbl. a day with 26 per cent submergence, and the quantity required to lift 1 bbl. at 65 per cent is only a little more than one-fifteenth that required to lift 1 bbl. at 26 per cent submergence.

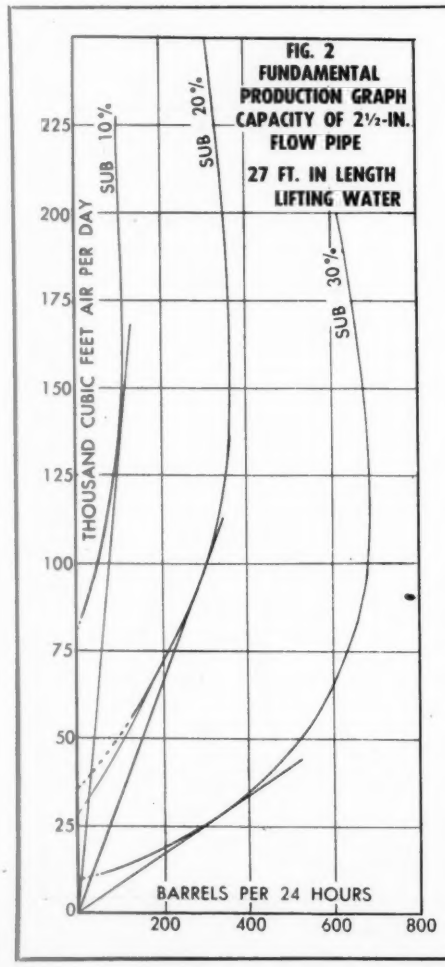
Fig. 2 indicates the maximum capacity of 2½-in. pipe 27 ft. in length, when lifting water at 10, 20 and 30 per cent submergence. At 10 per cent submergence the maximum capacity is about 120 bbl. a day, whereas with 30 per cent submergence the maximum capacity is about 690 bbl. a day or a capacity 5½ times as great as for 10 per cent submergence. In oil-field operations it is not possible to select any desired submergence, for this is fixed by the pressure that obtains at the bottom of the well when operating under the drawdown necessary to obtain the rate of production that is desired and possible.

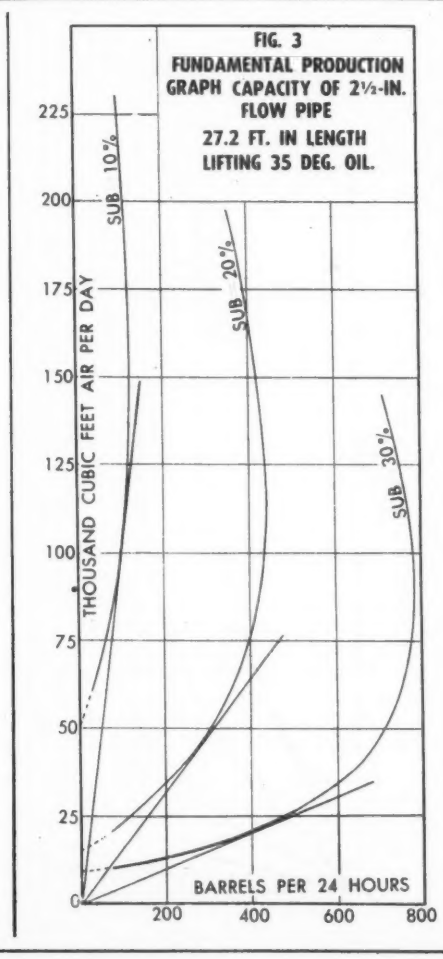
It will be observed in Fig. 3 that when lifting oil through 27 ft. of 2½-in. pipe, the rate of production for a given submergence is somewhat greater than when lifting water. This applies to East Texas oil of approximately 35-deg. API gravity when operating at temperature of about 85°F. The rate of oil production is increased or reduced depending on whether the temperature is increased or lowered. This will be discussed at greater length in a succeeding paragraph.

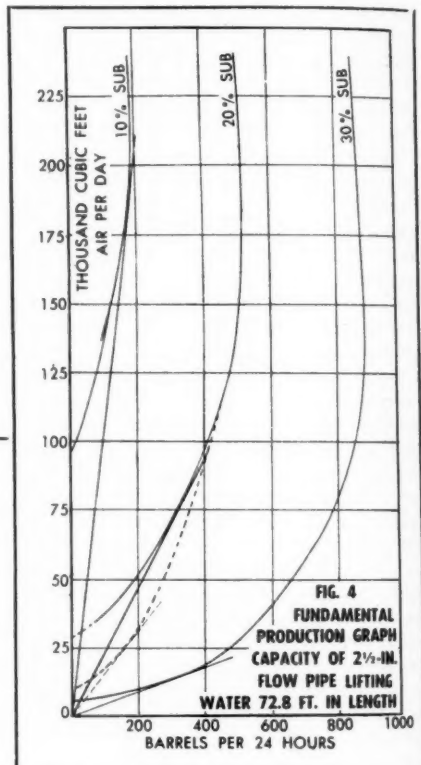
When producing water through 72.8 ft. of 2½-in. pipe, the maximum capacity is almost 190 bbl. a day when operating with submergence of 10 per cent, whereas it is about 690 bbl. a day with submergence of 30 per cent, which is more than 3½ times the capacity for 10 per cent submergence. (See Fig. 4.)

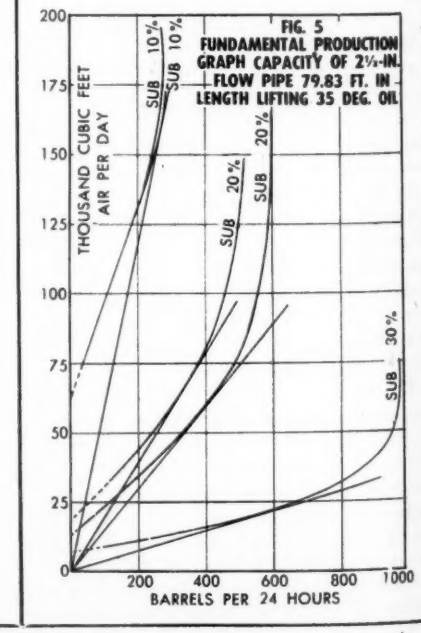
When lifting East Texas oil of about 35-deg. API gravity, through 2½-in. pipe 79.8 ft. long the maximum capacity at 10 per cent is about 290 bbl. a day, and at 30 per cent submergence the capacity is about 990 bbl. a day. (See Fig. 5.)

In Fig. 6 are shown graphs indicating the approximate maximum capacities of 1-in., 1½-in., 2-in., and 2½-in. pipe of given lengths when lifting at any submergence between 10 and 30 per cent. The graphs are drawn as straight lines between the submergence points, although it is obvious that the graphs indicate a curvature. The engineer would not go far astray, however, in using the graphs shown in Fig. 6. Corresponding graphs of maximum capacities are shown in Fig. 7 for 1-in., 1½-



in., 2-in., and 2½-in. pipe when lifting East Texas oil of about 35-deg. API gravity. There is no great difference between lifting water and 35-deg. oil in these pipes of small diameter and short lengths, although it would appear that in the 1-in. pipe the capacity is somewhat less when lifting oil than when lifting water, but when lifting oil in the 2½-in. pipe the capacity appears to be greater for oil than for water under a given submergence.

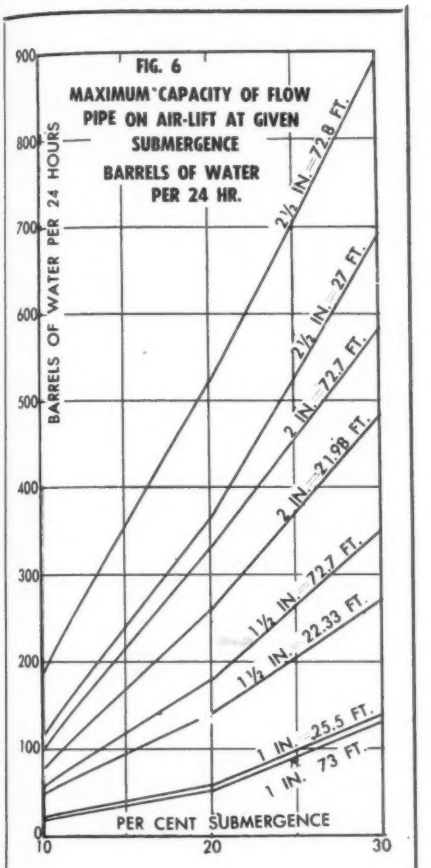



FIG. 6
MAXIMUM CAPACITY OF FLOW PIPE ON AIR-LIFT AT GIVEN SUBMERGENCE
BARRELS OF WATER PER 24 HR.

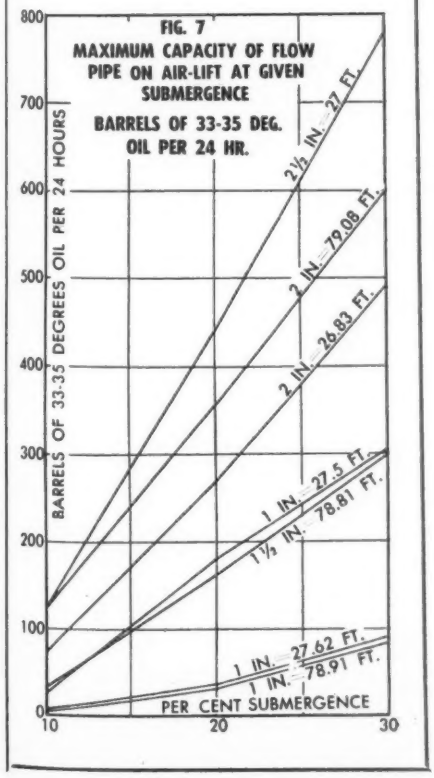



FIG. 7
MAXIMUM CAPACITY OF FLOW PIPE ON AIR-LIFT AT GIVEN SUBMERGENCE
BARRELS OF 33-35 DEG. OIL PER 24 HR.

● **Effect on capacity of increasing length of pipe.** The data indicate that when operating under a given submergence percentage, as the length of the pipe is increased the capacity is gradually increased. For instance, the capacity of 2½-in. pipe, 27 ft. in length under 30 per cent submergence is about 690 bbl. a day, but in a pipe 73 ft. in length operating under the same submergence the capacity is about 890 bbl. a day. Fig. 8 indicates the approximate capacity of 2½-in. pipe under 30 per cent submergence, up to 7000 ft. in length. This is obtained by extrapolating the graph between 27 and 73 ft. up to 7000 ft. This extrapolation is so far beyond the control points obtained at 27 and 73 ft., that the data taken from the extrapolated portion should be taken as only a very rough approximation. The merging of the graphs for oil and water at about 4500 ft. is probably incorrect. The reason for making actual tests in a well several thousand feet in depth is to determine control points so that extrapolations and interpolations would be more nearly accurate.

Not only is it important to set up graphs for small pipes at much greater depths, but it is desirable to determine such points for larger sizes of pipe, for in oilfield operations it becomes necessary to produce large quantities of water through larger diameter pipe in order to make the operation profitable. The writer is now handling wells where it is necessary to lift liquid containing 95 to 98 per cent water. It is not difficult to see that large quantities of liquid must be lifted daily in order to make a profit on such operations.

● **Effect of temperature on capacity of pipe.** An interesting observation was the effect of the temperature of the oil on the capacity of the pipe. Temperatures in these experiments could not be controlled at will, therefore a systematic investigation could not be carried out, for the prevailing temperature depended upon the time of day that the test was being conducted. Cooler temperatures were obtainable in the mornings and on cool days. The graphs in Fig. 9 show the effect on capacity of using different temperatures when producing through 2-in. pipe 79 ft. in length. The production with 10 per cent submergence was 113 bbl. a day with temperature of 74°F., and 124 bbl. a day at 83°F. When operating with 20 per cent submergence, and with increase in temperature from 74°F. to 83°F., the capacity was increased from 322 bbl. a day to 357 bbl. a day; and with submergence of 30 per cent the capacity was increased from 573 bbl. to about 600 bbl. a day, when the temperature increase was from 71°F. to 87°F.

When it is considered that temperatures in deeper reservoirs range up to 200°F. it can be seen readily that a large increase in the capacity results from operating with these high temperatures. It may be suggested that in these tests the gas dissolved in the oil under the higher submergence would have some effect on the productive capacity, and undoubtedly there would be some such effect under some conditions, but it should be remembered that the quantity of gas dissolved in the oil under the pressures employed in these tests was so slight that the influence would be so small as not to be measurable. It should be remembered, moreover, that when gas is dissolved in oil, the volume of residual oil is reduced, which offsets to a considerable extent the benefit that might otherwise be obtained when reducing the viscosity of the oil. Experiments carried out in the University of California by Prof. L. C. Uren and students brought out this comparison to a marked extent, and it was shown that the flow of dead oil through a sand body was much greater than the flow of live oil under similar pressures. Furthermore, tests made at the University of

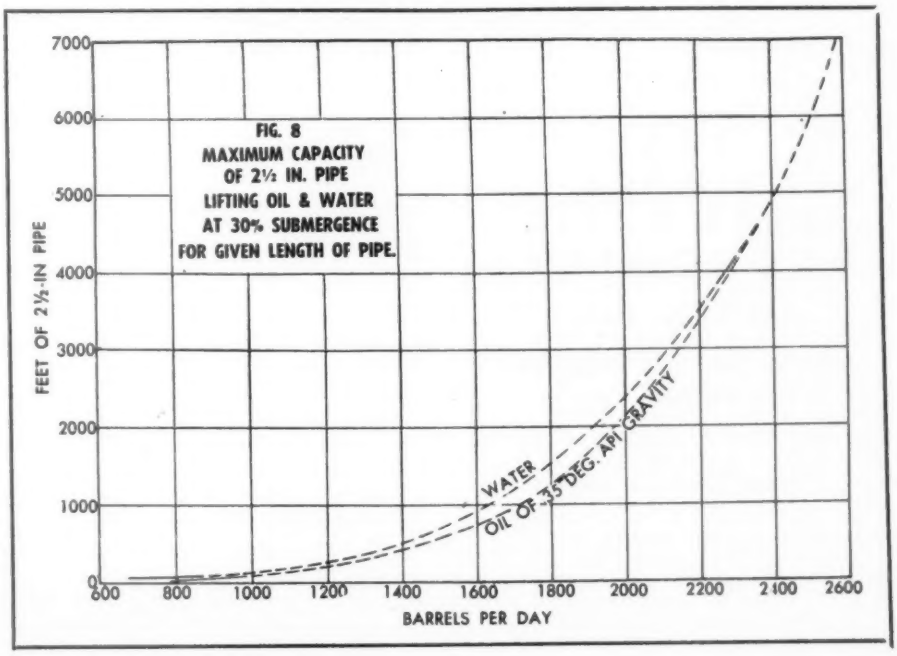



FIG. 8
MAXIMUM CAPACITY OF 2½ IN. PIPE LIFTING OIL & WATER AT 30% SUBMERGENCE FOR GIVEN LENGTH OF PIPE.

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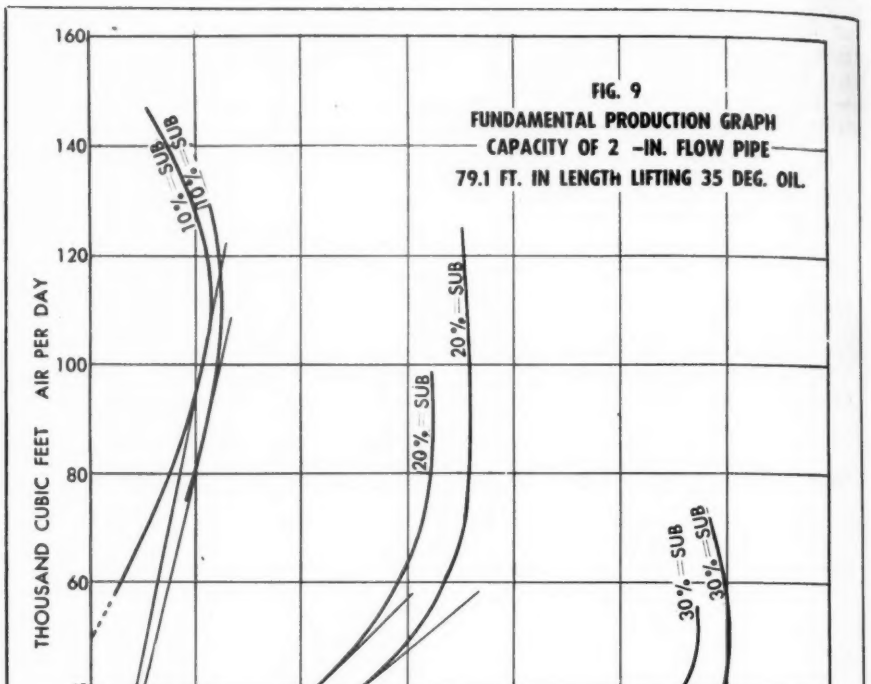


California indicated that great increase in flow took place through the sand when the temperature was increased from room temperature of about 55°F. to as high as 120°F.

It is not at all unlikely that a careful study of the production of oil through pipes by means of gas-lift under wide ranges of pressures and temperatures may, by analogy, give a better idea of the manner in which flow of oil and gas takes place through sand bodies.

For a continuation of these experiments it is now in order for some oil company having adequate facilities to carry on the project. Until this is done there will not be available a comprehensive knowledge of capacities of pipes of different sizes produced by gas-lift under different operating conditions. It may seem puzzling to the laboratory research worker why a subject of so great importance, and of which there exists so little knowledge, has not been thoroughly explored. It is due to the complex variable conditions involved in gas-lift work, to the impossibility of conducting the necessary tests in a laboratory, and to the large-scale operations required to carry it out. Only a large company could carry to completion such an undertaking. A parallel case is that in mining operations of finding the proper treatment for handling large bodies of low-grade ore where large mining companies install "pilot plants" for handling up to a thousand tons or more per day. A thousand-ton mill is a very large project for a small concern, consequently only large companies can undertake such a large laboratory scale of testing.

Oil wells are reaching to greater depths, and such reservoirs, especially those in Tertiary formations along the Gulf Coast of Texas and elsewhere, often produce such large quantities of water that it is a question from the point both of capacity and costs as to whether it is practicable to use any other method of lifting the liquid. In many instances such oilfields along the Gulf Coast are found in areas close to gas wells where large quantities of gas are available at low cost. Consequently, it would appear that careful investigation of this subject is very important. This method could easily become the means of recovering hundreds of millions of barrels of oil that otherwise would not be recovered.

This project at A. & M. College of Texas was sponsored by the Texas Engineering Experimental Station of which Thomas R. Spence was director until succeeded by A. A. Jakkula. The success in carrying the project to the point reached was due in large measure to the encouragement and assistance given by Prof. Harold Vance, head of the Department of Petroleum Engineering. After the work was laid out, most of the tests were made by P. J. A. Zeller, research associate of the Engineering Experiment Station. ★★★

# LIGHTING FOR OIL REFINERIES

By **DAVIS H. TUCK,** *Electrical Engineer*

**EXCLUSIVE** A PREVIOUS article published in *The Petroleum Engineer** discussed lighting applications for the producing areas of the refinery. This article will be concerned with lighting for the service areas.

Maintenance of lighting equipment in the production areas is the duty of the electrical shop, and for its use as well as for use by the design engineers, a discussion of the various practical in-service factors for all kinds of refinery lighting will be of value. Illumination calculations made by the average flux method give a theoretical average value of footcandles in an empty room when the job is new. If the calculations were made by the point-by-point method of calculation the footcandle results are more nearly those that can be measured in the work but this method also has the drawback of showing initial values and of making no allowance for practical conditions, which always have the effect of making the illumination lower than calculated values. This in-service factor is important to the maintenance department because it shows the practical value of illumination that can reasonably be expected, and when the values fall below this figure it will be the job of the maintenance man to bring them back to normal. The in-service factor is important to the design department because it gives the proper factors by which the design illumination must be increased for obtaining the desired in-service values.

● **Lamp depreciation.** The initial lamp lumens gradually decreases during lamp life and small over voltage values greatly accelerate this lumen depreciation (a 2 per cent voltage increase will cause the lamp life to be decreased by 20 per cent). The lumen output at 70 per cent of normal life is usually taken as the average lumen value during life. This value for lamps ordinarily used is shown in Table 1.

*August, 1943.

**TABLE 1**
**Lamp depreciation factors.**

| Lamp size, watts | Factor { lumens at 70 per cent life / lumens initial } |
|---|---|
| Incandescent | |
| 75 | 0.91 |
| 100 | 0.95 |
| 150 | 0.90 |
| 200 | 0.88 |
| 300 medium base | 0.87 |
| 300 mogal base | 0.89 |
| 500 | 0.85 |
| 750 | 0.87 |
| 1000 | 0.83 |
| 1500 | 0.71 |
| Fluorescent | |
| 30 | 0.79 |
| 40 | 0.84 |
| 100 | 0.79 |
| Mercury | |
| 400 | 0.88 |

● **Dirt and dust on lamp and reflector.** The factor to apply for dirt and dust will be determined by the type of service and by the efficiency of the maintenance. For instance, the dirt and dust conditions in a brass foundry would be more severe than in a machine shop. In some plants the maintenance program calls for a reflector cleaning at each lamp renewal, whereas in other plants the reflectors are seldom if ever cleaned. Table 2 shows dirt and dust factors that have been compiled from practical experiences.

***Practical suggestions for engineers designing new construction and for maintenance departments checking performance.***

● **Voltage drop and under voltage.** Lighting calculations are all based on the lamp lumens at normal operating voltage, i.e. when the voltage measured at the socket at full load corresponds to the rated voltage of the lamp. Even the best wiring layouts allow for a 2 per cent drop in the feeders and branch circuits and when lighting service is taken from power circuits this drop is often much greater. The practical voltage limit below or above normal is much more critical for fluorescent and mercury lamps than for incandescent lamps. A line voltage 6 per cent below rated ballast voltage may cause uncertain starting and a 6 per cent voltage above rated ballast voltage may result in ballast failure. It is the practice in some plants to operate lamps under voltage to compensate for over voltage periods that occur at definite times and extra allowances must be made for such cases. Table 3 shows low voltage factors resulting from normal feeder and branch circuit voltage drop.

**TABLE 2**
**Dust and dirt factors for various conditions.**

| Condition | Fluorescent* and mercury lamps | Incandescent lamps |
|---|---|---|
| Clean location, good maintenance | 0.8 | 0.9 |
| Clean location, poor maintenance | 0.7 | 0.7 |
| Dirty location, good maintenance | 0.7 | 0.8 |
| Dirty location, poor maintenance | 0.5 | 0.5 |
| Very dirty location, good maintenance | 0.6 | 0.7 |
| Very dirty location, poor maintenance | 0.4 | 0.4 |

*Fluorescent and mercury lamps have a longer life than incandescent lamps so they are not serviced so often.

● **Lamps out factor.** There are usually some lamps that are not burning because they have burned out and have not been replaced or a fuse is out or the circuit is open from other causes. This factor is much more serious for fluorescent lamps than for incandescent or mercury lamps because there are many more lamps and more causes for the lamp to fail and there is a tendency not to replace one or more lamps in a multi-lamp fixture. Plants having poor dust and dirt maintenance usually also have more lamps out. Table 4 gives lamp out factors for various conditions.

● **Interception factor.** In making illumination readings with a footcandle meter it is common but erroneous practice to measure the illumination on a horizontal plane 30 in. above the floor at an open location and to turn the instrument so that no shadow falls on it. Footcandle readings should be made *at the work with the worker in his normal working* position and on the plane of the work regardless of whether it is hori-

**TABLE 3**
**Voltage drop factors.**

| Condition | Factor |
|---|---|
| Socket volts—2 per cent less than lamp voltage rating, incandescent and mercury | 0.94 |
| Outlet volts—2 per cent less than ballast voltage rating, fluorescent | 0.98 |
| Socket volts—3 per cent less than lamp voltage rating, incandescent and mercury | 0.91 |
| Outlet volts—3 per cent less than ballast voltage rating, fluorescent | 0.97 |
| Socket volts—5 per cent less than lamp voltage rating, incandescent and mercury | 0.855 |
| Outlet volts—5 per cent less than ballast voltage rating, fluorescent | 0.95 |
| Socket volts—10 per cent less than lamp voltage rating, incandescent and mercury | 0.70 |
| Outlet volts—6 per cent less than ballast voltage rating, fluorescent | 0.93 |

**TABLE 4**
**Lamp out factors.**

| Condition | Factor |
|---|---|
| Incandescent and mercury lamps, good maintenance | 0.95 |
| Incandescent and mercury lamps, poor maintenance | 0.90 |
| Fluorescent lamps, good maintenance | 0.85 |
| Fluorescent lamps, poor maintenance | 0.80 |

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zontal or vertical or at some intermediate angle. The purpose of making an illumination reading is to determine the footcandles on the work and not at some theoretical location. Interception of light by machine parts, structural parts, the worker's body, the product and tools takes a heavy toll. Unfortunately the interception becomes greater at the higher angles from the vertical and it is these angles where the solid angle content of the zone is greatest (the solid angle content of the 0-10 deg. zone is 0.095 and for the 60-70 deg. zone is 0.992 deg. so that for equal candlepower at these angles there is approximately 10 times as many lumens in the 60-70 deg. zone as in the 0-10 deg. zone). Plans sections and elevations of the space to be lighted with the machines drawn to scale are of great help in estimating interference when calculating illumination by the point by point system. The usual practice is to omit all contributions from units at angles above 45 deg. from the vertical. When the average flux method of calculation is used the interception factor can be taken as the ratio:

$$\frac{\text{Lumens in 0-45 deg. zone}}{\text{Lumens in the 0-90 deg. zone}}$$

The magnitude of the interception factor for general lighting ordinarily is in the order of 0.6. When the lighting is carefully arranged with special reference to the work, such as local or local-

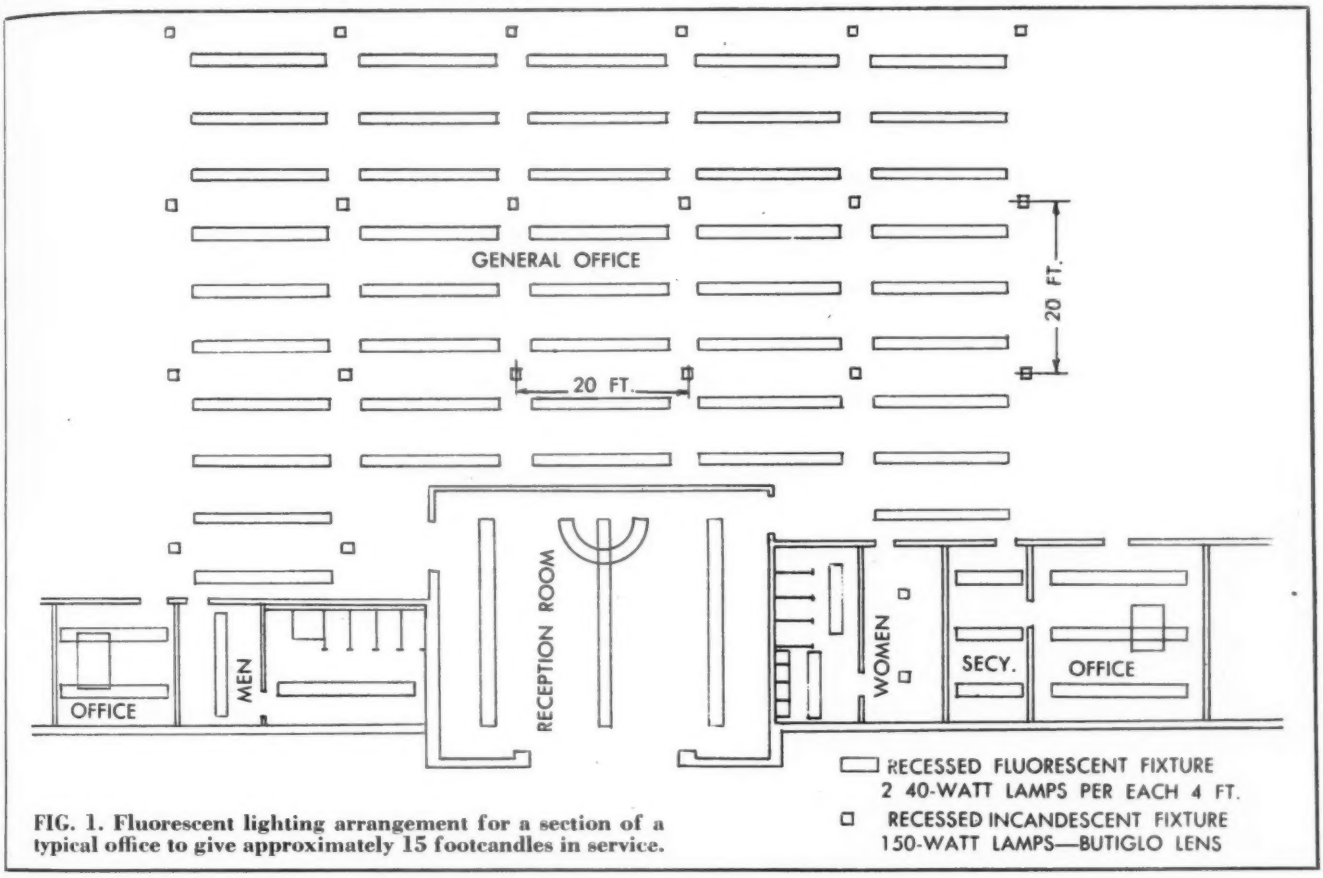


**FIG. 1. Fluorescent lighting arrangement for a section of a typical office to give approximately 15 footcandles in service.**

**FIG. 2. Unretouched photograph of a drafting room designed to give 75 footcandles initially. Note that the rows of fluorescent units run in the direction of the line of sight to minimize glare. The lighting fixture is recessed and the bottom covered with control lenses so that the light flux in the 60-90 deg. zone is reduced without reducing the useful light.**

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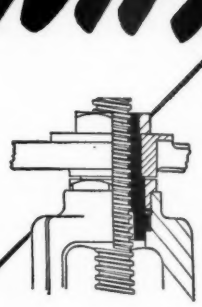

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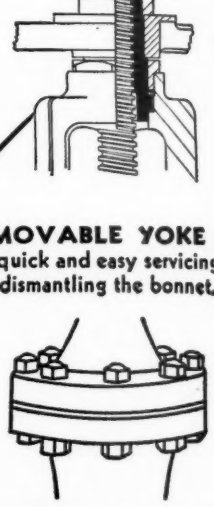

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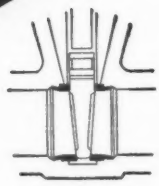

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ized general lighting, and a favorable light distribution is employed the interception may be greatly reduced. In general the lighting units having a wide spread of light like an RLM reflector have interception factors of approximately 0.5 and narrow spread units like high bay reflectors have an interception factor of approximately 0.8.

● **Atmosphere absorption.** There are many locations where smoke, fumes, vapors, fog, and dust are present in the air to such an extent that its absorption must be taken into account. The in-service factor necessary to compensate for this absorption must be determined from similar existing installations. A practical method for determining this factor is to measure the illumination at several locations during operating hours and again when the atmosphere is not contaminated. In some instances the effect of high relative humidity makes conditions worse and it will be necessary to determine the frequency and duration of such conditions in determining the factor for use.

The in-service factor will then be the product of the various separate in-service factors (lamp depreciation × dust and dirt × voltage drop × lamps out, × interception, × atmosphere absorption).

This in-service factor when multiplied by the calculated illumination will give the footcandle value that the maintenance department should be able to read with a light meter.

● **Fundamental "musts."** Whenever an engineer is called upon to make a lighting design for any area there are two fundamental "musts" that should be observed.

1. *The primary function of the eyes is for orientation and their secondary function is for seeing.* A large part of the energy expended by a worker is for orientation and usually a much smaller part is for seeing, e.g. a truck driver only uses his eyes for seeing when reading a

*(Continued on Page 120)*

**FIG. 3. Lighting arrangement for a typical chemical laboratory using flush daylight blue control lens equipment for general lighting and local fluorescent lighting for the hood and balances.**

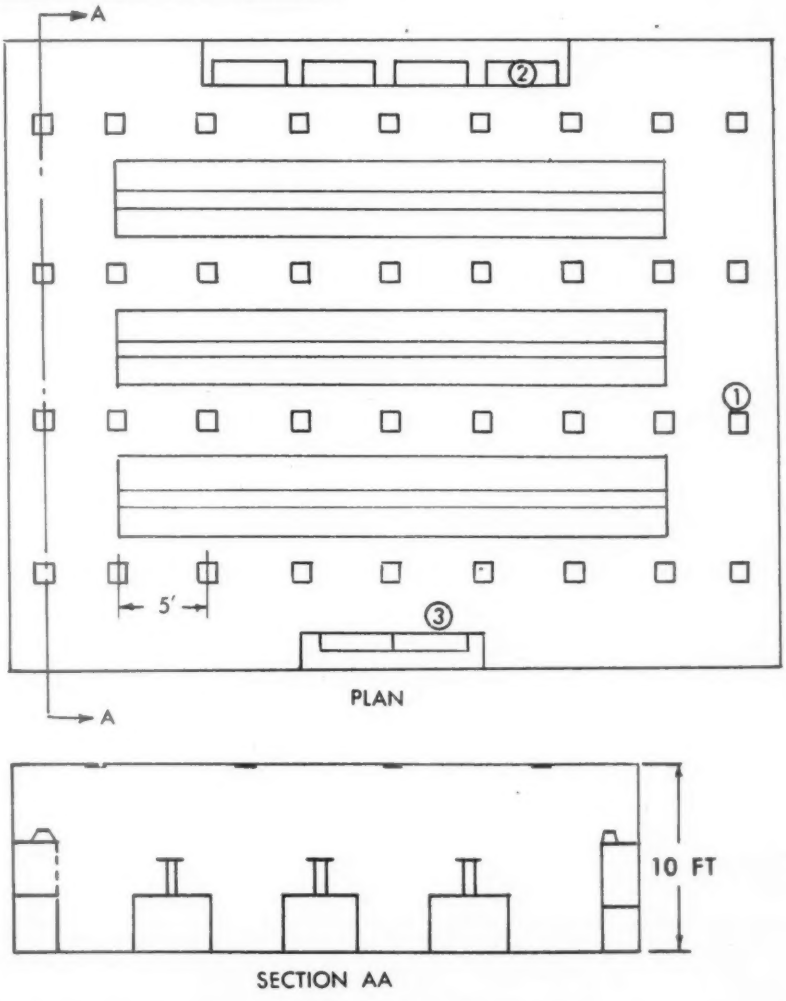
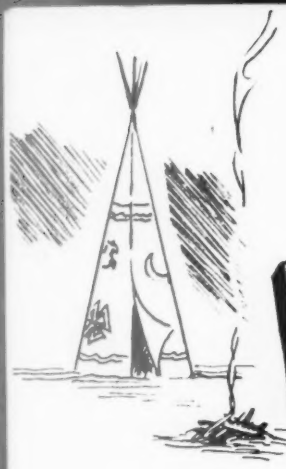



**FIG. 4. Unretouched photograph of a modern chemical laboratory that meets the requirements for highly satisfactory laboratory lighting. The flushed lens units are vaporproof to minimize depreciation.**



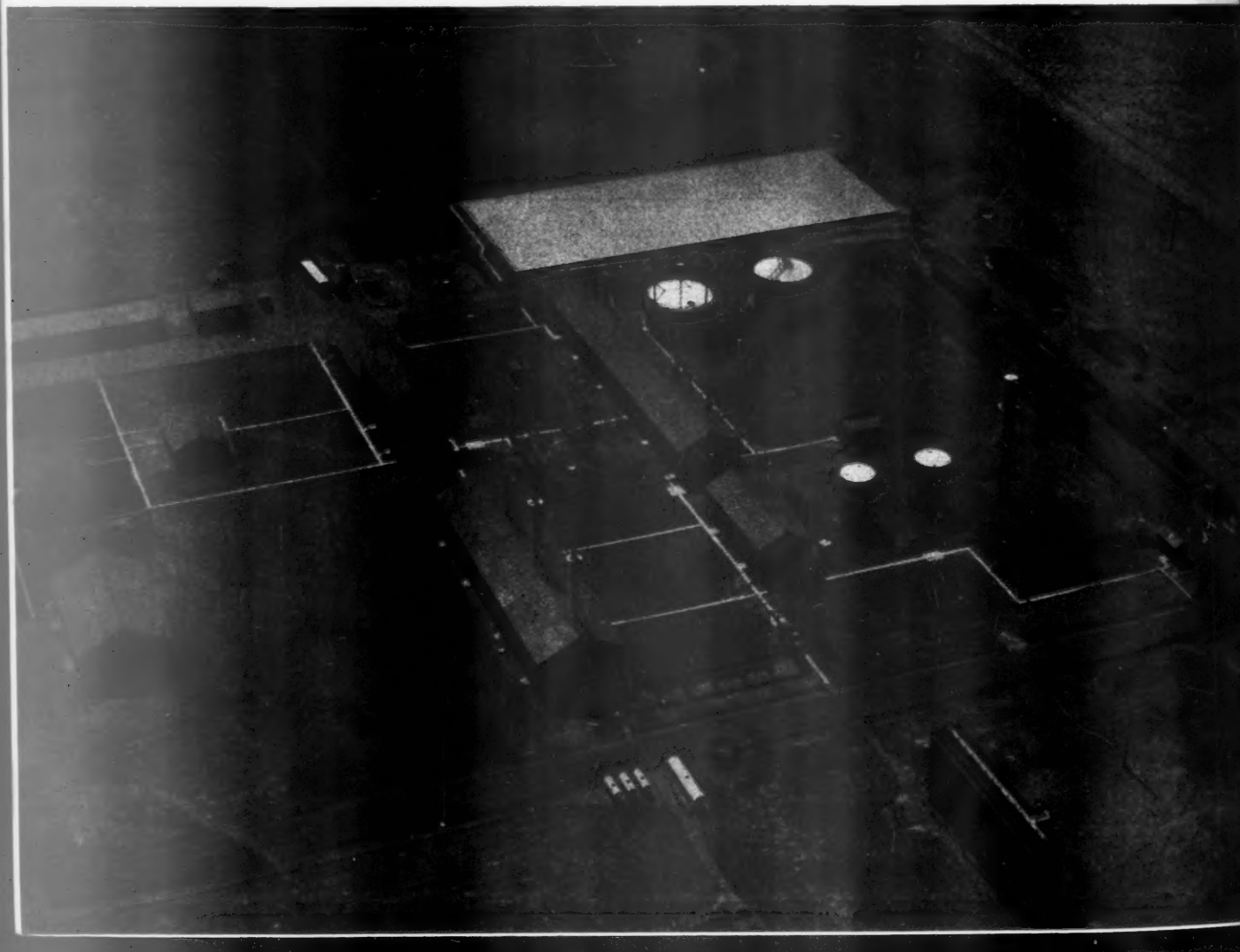
# NAVAJO HELIUM PLANT

Completion of the United States Bureau of Mines NAVAJO Plant to recover pure helium from gas produced from the Rattlesnake Field again demonstrates the versatility of HUDSON in completing all phases of a gas processing project within its own integrated engineering and construction organization.

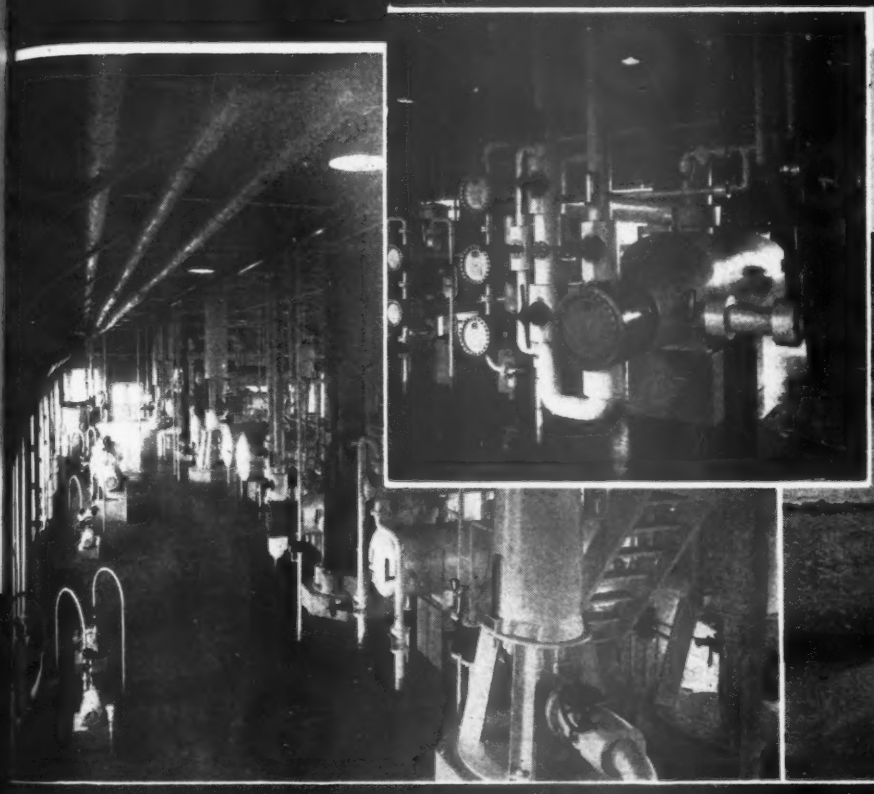
In addition to the gas processing units, other facilities including gathering lines from the helium bearing gas wells, a complete village for the operating personnel, water, gas and power distribution systems, a 35 mile fuel gas pipe line, and a 90 mile pure helium pipe line to the railroad at Gallup, New Mexico, were also constructed by Hudson as parts of this complete project.

This plant was constructed on the Navajo Indian Reservation near the village of Shiprock in the northwestern corner of New Mexico. Navajo Indians were extensively employed in the construction of the project.

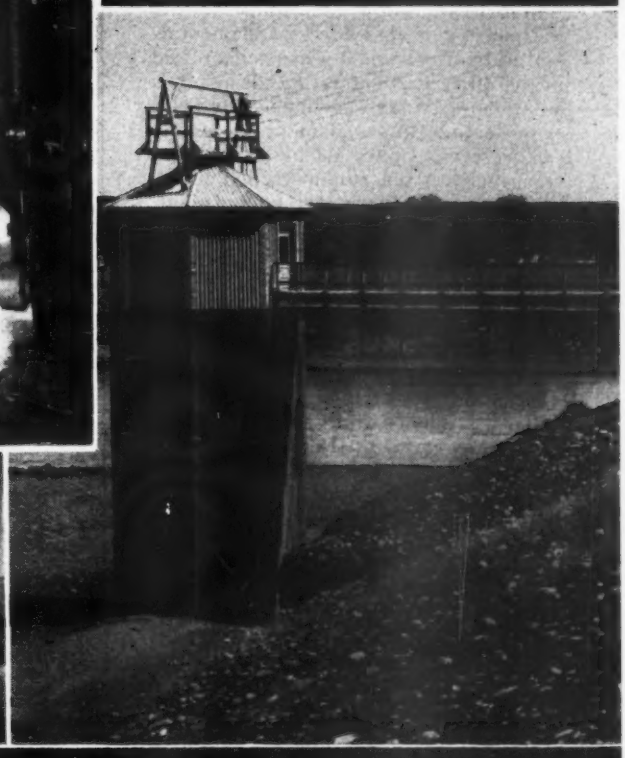
Process equipment is housed in center buildings, and compressor and boiler houses are shown at right. Storage facilities for pure helium, impure helium, and nitrogen are shown at right background.



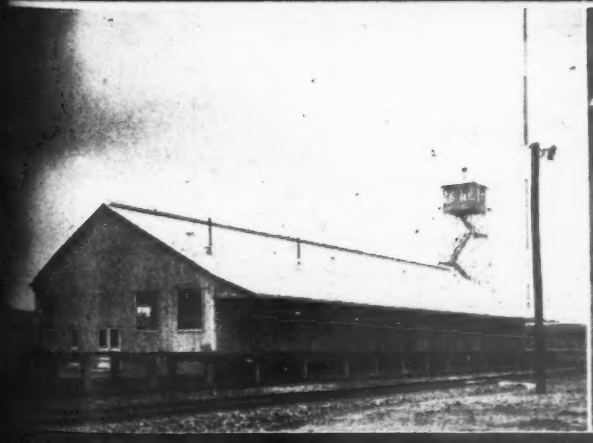
# designed and constructed by HUDSON



Interior views of one of the process equipment buildings. Fractionating columns extend through roof



Plant and domestic water is obtained from San Juan river



Additional helium storage was constructed at terminus of 90 mile helium pipe line at Gallup, New Mexico. Picture shows building housing facilities used in connection with loading helium at Gallup for rail shipment

General view showing housing facilities

## HUDSON ENGINEERING CORPORATION

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*(Continued from Page 117)*

sign, etc. In oil refinery work the greater part of a workman's energy is used in orientation. Much less light is required for orientation than for seeing.

2. *The brightness of the actual work (light reflected to the eyes) should be at least as great as the brightness of the immediate surroundings.* Both of these fundamentals indicate the advisability of a combination lighting system—a lower level of general lighting for orientation and for keeping the brightness of the surroundings below that of the actual work, and local lighting for seeing and for bringing the brightness of the work (light for seeing) up to that of the surroundings.

When a lighting system fulfills the requirements of these two fundamentals and ordinary common sense is exercised in the other particulars, the designer is assured of having an economical and otherwise satisfactory system.

The service space found in oil refineries includes the administration building, chemical laboratory, boiler plant, power generating plant, machine shop, carpenter shop, pipe shop, electrical shop, warehouse, outdoor storage of heavy material, and garage.

● **Administration building.** Fluorescent lighting is the popular choice for office and drafting rooms. It does not necessarily follow that fluorescent lighting is the best choice from the standpoints of economy or for the best seeing conditions*. Mob psychology, however, dictates fluorescent lighting for the immediate future at least.

Modern office lighting using fluorescent fixtures of the better grade should have 15 footcandles in service. The in-service factor will be approximately $(0.84 \times 0.8 \times 0.97 \times 0.85 \times 0.5 \times 1.0)$ 0.28, depending on local conditions, so the design illumination should be $\left(\frac{15}{0.28}\right)$, approximately 54 footcandles. This will require approximately 2½ watts per sq. ft. of floor area. Forty-watt white fluorescent lamps will be the most satisfactory and insofar as possible the rows of fluorescent lights should be placed parallel to the direction of vision and not perpendicular to the line of vision. Fig. 1 shows a part of a typical office and a lighting layout that will conform to good practice. The colors of the walls, ceiling, floor, and furniture are important for

*Dr. D. B. Harmon, director, Division of Education Services, Texas State Department of Health, Austin, Texas, Tr. Ill Eng. Sec., September, 1944, p. 481.

## Heidelberg plant

Priorities for construction of a refinery in the Heidelberg oil field area of Jasper County, Mississippi, have been granted and work on the plant will begin immediately, according to Governor Thomas L. Bailey.

Rogers Lacy, Longview, Texas, who owns producing wells in the Heidelberg field, will build and operate the plant.

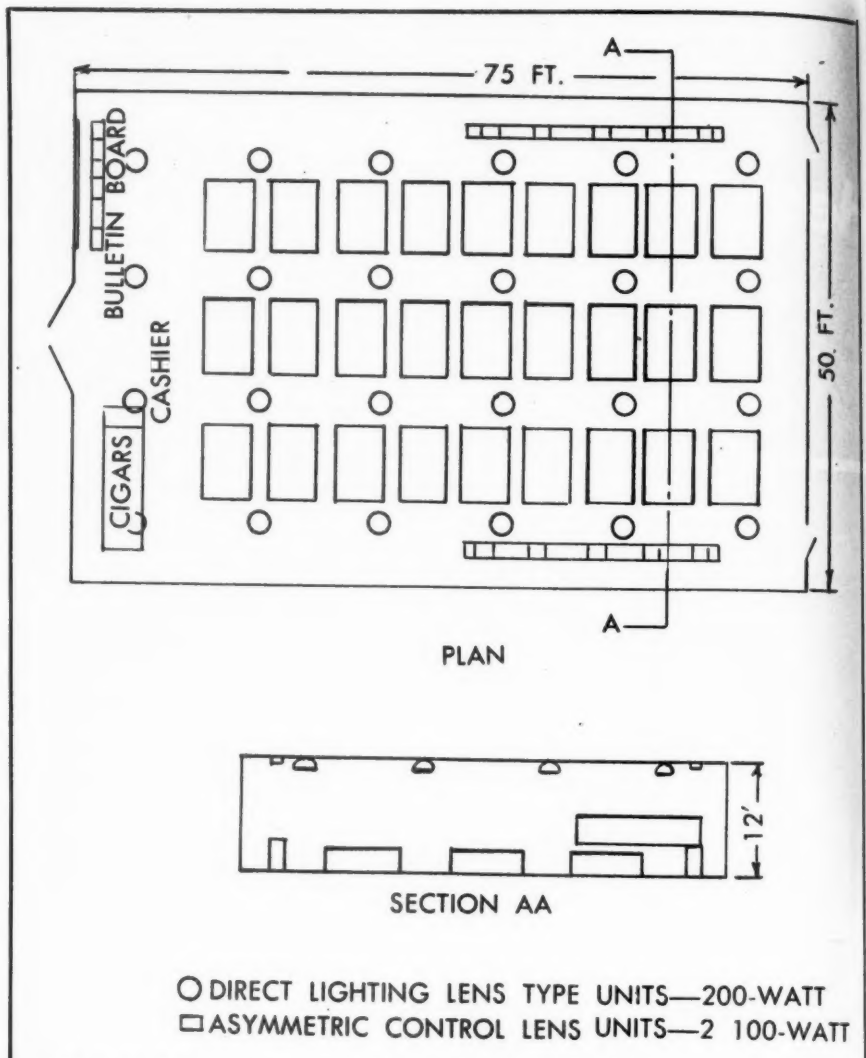


**FIG. 5. Lighting arrangement for a typical cafeteria. Incandescent general lighting for the tables and additional local lighting for the bulletin board and food counters.**

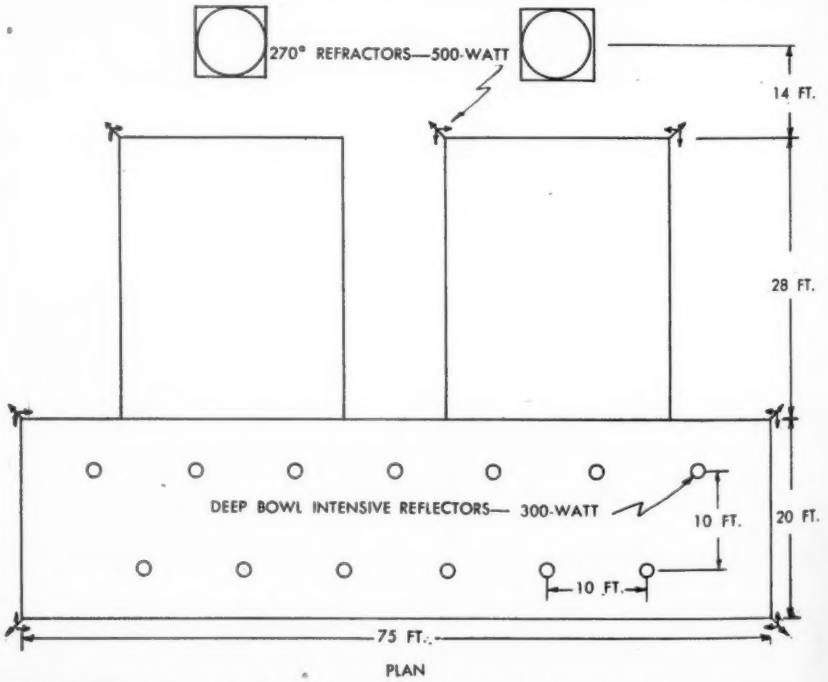


**FIG. 6. Plan of a typical outdoor boiler plant showing location and types of lighting equipment.**

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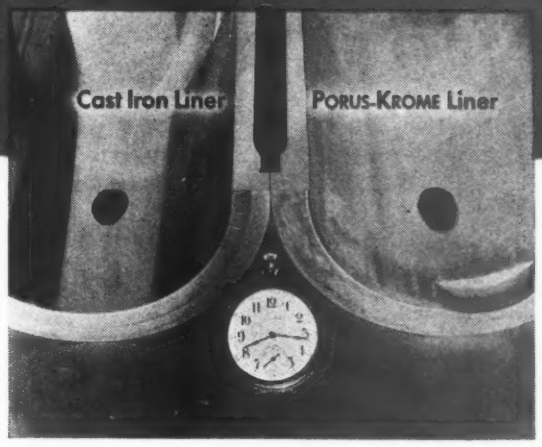
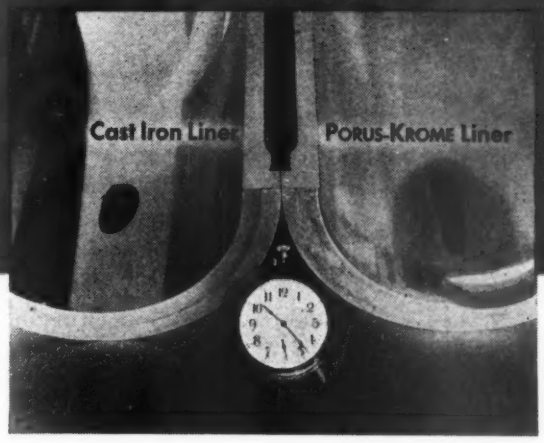
## *multiplies cylinder life*




*The porosity of PORUS-KROME assures better lubrication.* The tiny pores and channels in its surface serve as reservoirs for lubricating oil, feeding it back to the surface as needed. PORUS-KROME "wets" with oil many times better than cast iron does . . . and these photographs demonstrate that the rate of dispersion is a function of porosity.

Drops of oil (as shown above) are placed on a conventional cast-iron liner and on a liner which has had PORUS-KROME applied by the patented Van der Horst process. Both have been honed to the same degree of smoothness. The time is noted.

*Two hours later.* We see in the photograph on the right that the oil has dispersed only slightly on the cast-iron surface. On the PORUS-KROME liner, the oil has dispersed over a much larger area.

This, combined with the other characteristics of PORUS-KROME, enables it to multiply the life of cylinder liners from 4 to 20 times . . . and at the same time multiply the life of ordinary rings 3 to 5 times.

In addition to providing a "long-life" cylinder wall surface, PORUS-KROME has many diversified applications. If you have troublesome wear problems on any parts of your machines or equipment, or are seeking a way to give your customers an added value in your products, Van der Horst engineers may be able to supply the solution for you. Write today telling us just what your problems are . . . no obligation, of course. Van der Horst Corporation of America, Olean, N. Y. Plants in Olean and in Cleveland, Ohio.

**PORUS-KROME** VAN DER HORST

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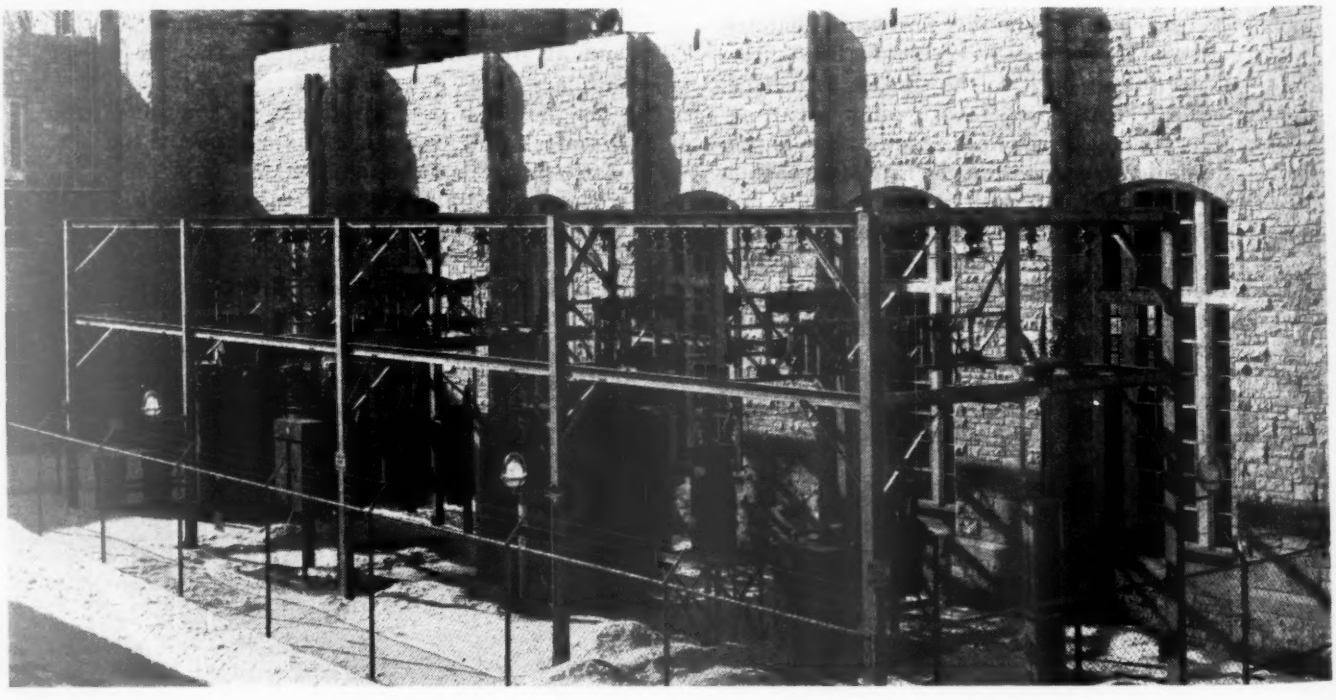
satisfactory office lighting. The wall should be finished with No. 4 deep blue green (reflection factor 10 per cent) to a height of 4 ft. above floor, with No. 2 light blue green (reflection factor 25 per cent) for the next 3 ft. and No. 1 light blue green (reflection factor 60 per cent) on up to the ceiling. This is a 9-ft. ceiling. For other ceiling heights the bands should be in proportion. The ceiling should be finished off white (gray) (reflection factor 75 per cent). The floor should be finished with linoleum, paint, or carpet having a reflection factor of 30 per cent. The furniture (desks, chairs, files, etc.) should be finished to have a reflection of 50 per cent. All surfaces should be dull finished and no glass top desks should be used. Lighting fixtures should be recessed in the ceiling wherever possible and the openings should be covered with control lenses or louvers to limit the flux of light in the 60-90 deg. zone. The units should use two, three, or four lamp ballasts of the high power fac-

*(Continued on Page 126)*

**FIG. 7.** ***Above*****—Cranelite for supplementary lighting under cranes. The compound spring suspension prevents lamp failure from vibration and shock.**

**FIG. 8.** ***Right*****—Typical outdoor substation unit. Units are mounted on brackets approximately 8 ft. from the ground and throw the light up to the disconnects and also give sufficient down light for operating purposes.**

**FIG. 9.** ***Below*****—Daylight photograph of an outdoor substation shows location of the lighting equipment. The lighting units have an adjustment so that the angle of maximum candlepower can be changed to suit the individual conditions.**

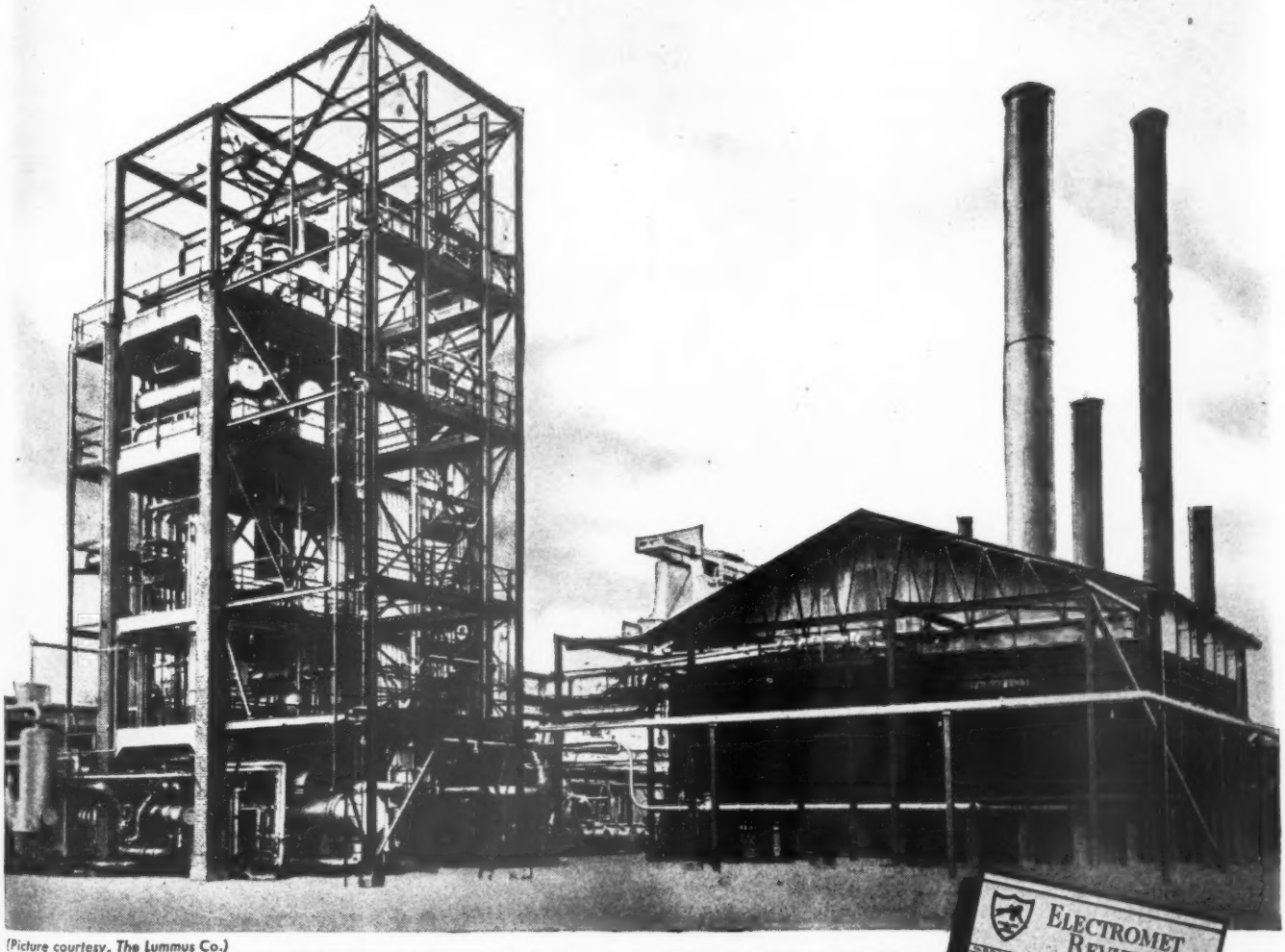


# *Old-Age Insurance for Cracking Tubes*

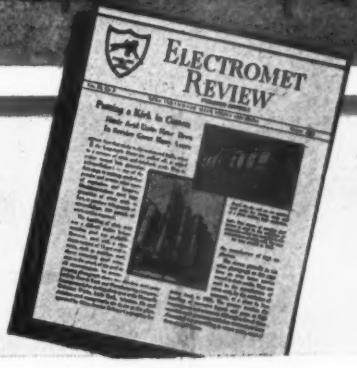
**Chromium steel cracking tubes are used in this modern furnace installation because good resistance to oxidation and hot oil corrosion is a "must." Laboratory and field tests clearly show that the life of tubes—and of tube supports, too—varies with chromium content of the steel.**

**In addition to the 4 to 6 per cent chromium steels so commonly used in refining equipment, many high-chromium steels are specified for high-temperature processes and the handling of highly corrosive crudes. Chromium steels should always be considered for applications where corrosion or oxidation resistance is required.**

***BUY UNITED STATES WAR BONDS AND STAMPS***



*(Picture courtesy, The Lummus Co.)*




**Other interesting uses of stainless steel are described in ELECTROMET REVIEW published by ELECTRO METALLURGICAL COMPANY, the Unit of UNION CARBIDE and CARBON CORPORATION that produces alloys for making steel. If you are an executive, engineer, or designer you can be put on the mailing list for ELECTROMET REVIEW by sending your name on your business letterhead to ELECTRO METALLURGICAL COMPANY, Room 328, 30 East 42nd Street, New York 17, N. Y.**

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# . . . The EDELEANU $SO_2$ EXTRACTION PROCESS

*(Continued from Page 122)*

tor type to minimize stroboscopic effect. In buying fluorescent lighting equipment it should be remembered that like other things, you get about what you pay for and "cheap" equipment is not recommended.

Drafting room lighting should be of the same type as for general office space only the initial footcandles should be increased to 75. This increase in illumination is usually procured by increasing the number of fluorescent lamps per fixture and in the case shown in Fig. 1 the 75 footcandles will be obtained by using three 40-watt lamps per fixture instead of two lamps.

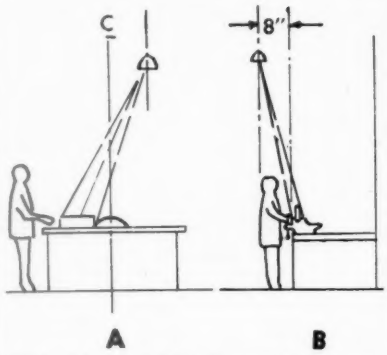



**FIG. 10a and 10b. Proper location of lights for a saw (10a) and for a work bench (10b).**

● **Chemical laboratory.** Lighting for the chemical laboratory should be of good color value and the equipment should be made of material that will not discolor or deteriorate under the action of acid fumes, alkali fumes, and moisture. An in-service illumination of 15 footcandles is required. Fluorescent lighting is not suitable for chemical laboratories because the mercury lines coming through the fluorescent lamp causes color distortion. It is important to place the lights with special reference to the benches, sinks, and tables to obtain light from the most advantageous directions. Incandescent fixtures with daylight blue color correcting glass should be used. The in-service factor will be $(0.88 \times 0.8 \times 0.91 \times 0.95 \times 0.68)$ 0.41 and the design illumination will be $\left(\frac{15}{0.41}\right)$ 37 footcandles. It is desirable to flush the lighting equipment into the ceiling if possible. Fig. 3 shows a typical lighting arrangement for a chemical laboratory.

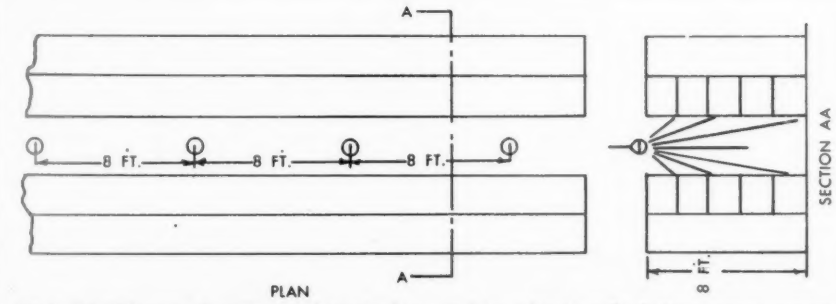



**FIG. 11. Plan and section of typical stock bins showing lighting arrangement for uniform vertical illumination.**

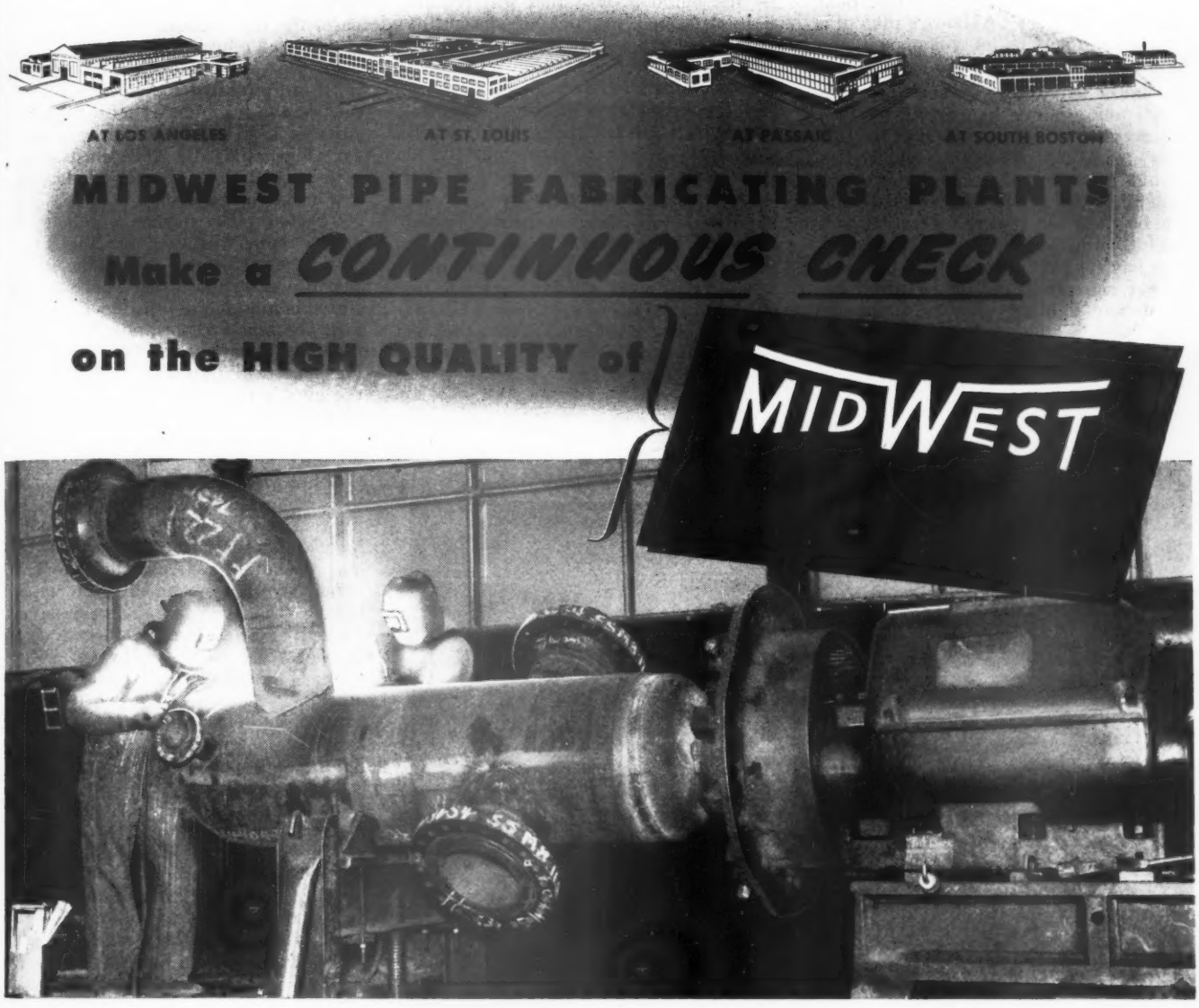
● **Cafeteria.** Lighting for the cafeteria should be of a type to create a cheerful, restful atmosphere, of good color value and of sufficient quantity to promote cleanliness. General incandescent lighting should be used (not fluorescent because of poor color value) with additional local lighting at the food counters. The illumination should be 5 footcandles in service, which will require

$$\left(\frac{5}{0.88 \times 0.9 \times 0.91 \times 0.95 \times 0.52}\right)$$

14 footcandles of design illumination. Special attention should be given to the color of the walls, ceiling, floors, and fixtures. The walls should be painted a warm color of the yellow family with a reflection factor of approximately 70 per cent. The lower 5 ft. of the walls may be darker (30 per cent reflection factor.) The ceiling should be white and the floor light gray or tan (reflection factor 40 per cent). The fixtures should be of light color such as the bleached woods (reflection factor 40 per cent). Pine paneling finished light makes a satisfactory wall finish. Fig. 5 shows a satisfactory lighting arrangement for a typical cafeteria. Germacidal lamps can be used to good advantage in a cafeteria.

● **Boiler plant.** Boiler plants are usually of the outdoor type, the firing aisle being the only part under roof. The firing aisle is lighted by deep bowl medium spread units to give an in-service illumination of 10 footcandles. The outdoor part of the boiler plant is lighted with 500 watt standard refractor units having a

**FIG. 12. Outdoor storage yard at Torrance, California, using 180 and 360 deg. standard refractors.**

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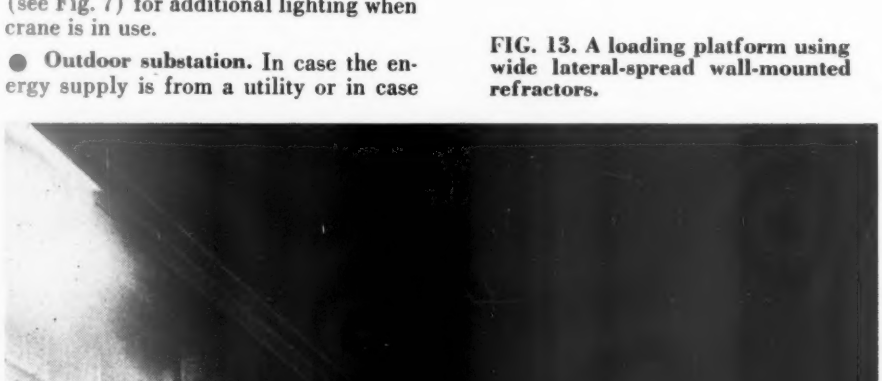
lateral spread of 270 deg. and an angle of maximum candlepower in the vertical plane of 75 deg. Fig. 6 shows a plan of a typical outdoor boiler plant and the lighting arrangement.

● **Power generating station.** Lighting practice for power generating stations follows good utility practice. For the turbine room 20 in-service footcandles should be provided and arranged for switching so that one-half of this value can be used for routine operation and the full value for repairs, etc. Standard high bay type reflectors should be used. One or more units should be wired for emergency lighting with an automatic throw-over to other sources of supply in case of interruption of service. The crane should be equipped with two cranelites (see Fig. 7) for additional lighting when crane is in use.

● **Outdoor substation.** In case the energy supply is from a utility or in case of standby or emergency tie-in to a utility the outdoor substation will require lighting. Good practice of the utility should be followed, which is to install outdoor substation units shown in Fig. 8 with 300-watt lamp on brackets fastened to the columns at a height of approximately 8 ft. from the ground. Units should be spaced on approximately 30 ft. centers. Fig. 9 shows a typical substation with lighting equipment.

● **Shops—machine, carpenter, pipe, electrical, blacksmith.** Repair shop areas should be well lighted because it is often necessary to make quick emergency repairs and all types of work must be done. Good practice in other industries such as shipbuilding or steel should be followed.

**FIG. 13. A loading platform using wide lateral-spread wall-mounted refractors.**



An in-service illumination of 15 footcandles should be provided. In many cases the light should be arranged with special reference to the machines such as a saw, bench, etc., where the light must fall unobstructed on the important part of the machine. Liberal use of adjustable local lights should be provided for. Figs. 10a and 10b illustrate the proper position of overhead lights for a saw and a work bench.

● **Storage.** The storage warehouse for an oil refinery is used for spare parts storage and for raw materials used in the process. Spare parts are usually stored in bins and require stock bin lighting. The bins are normally 7 ft. to 8 ft. high with a narrow aisle common to two bins. Vertical lighting on the faces of the bins is required and is obtained by special asymmetric reflectors that control the candlepower distribution so that not only the top of the bin gets illumination but also the bottom. Fig. 11 shows the arrangement of lights for stock bin lighting. An in-service illumination of 5 footcandles should be provided for general open storage areas. They should be arranged for convenient switching of lights so that the main aisles can be kept lighted and local areas turned on as desired.

For outdoor storage yards for pipe and other heavy material, it is customary to have an outdoor crane way to facilitate handling materials. Highly satisfactory lighting for such outdoor storage yards is obtained by suspending standard refractor units on shock absorbers under the crane rail. One hundred and eighty degree lateral light distribution refractors are used on the building side and 360 deg. lateral light distribution refractors on the open side. Five hundred-watt lamps are used in the refractors. Additional outdoor crane lights are also provided. Fig. 12 shows a typical outdoor storage yard.

The shipping platform for incoming and outgoing maintenance material is lighted by refractor lenses mounted on the building wall. The lateral distribution of light is 180 deg. and the vertical distribution is 60 deg. above the vertical. Lighting of this type enables workers to see into a truck or railroad car. Three hundred-watt lamps should be used and units should be spaced on approximately 20 ft. centers and mounted approximately 8 ft. above the floor of the shipping platform. Fig. 13 shows a typical loading platform and Fig. 14 shows the method of layout for the wall-mounted refractor.

★★★

**FIG. 14. Detail of installation for the wall-mounted wide lateral-spread refractor for lighting shipping platforms.**

# LUMNITE CEMENT IN REFRACTORY CONCRETE*

By **JAMES E. LUDBERG,** *Patcher Foreman, Gary Coke Works,*
Carnegie-Illinois Steel Corporation†

ALTHOUGH Lumnite cement has, from time to time, proved invaluable for its quick setting property, in most cases concrete made with it has been used for its refractory properties. When made with suitable aggregate, Lumnite concrete has in certain instances supplanted high grade refractory bricks and shapes. In many cases it has replaced Portland cement concrete where that material had a tendency to disintegrate under the influence of elevated temperatures.

The earliest experiments made with refractory concrete at Gary were in the lining of oven doors, a troublesome item of maintenance in almost any coke plant. In the original experiments, where monolithic linings were cast into conventional cast-iron doors, many failures were experienced from the shearing off of large pieces of the concrete that projected beyond the metal body of the door. The first remedial step was to subdivide the door into two separate blocks by means of iron or steel plates. Considerable improvement in performance of the linings resulted from this practice. The present practice is to subdivide the linings into three of four blocks with pitch-coated 16-gage plates or plywood fillers. Further improvement, to the extent of consistent success, resulted from heavily coating the inside of the door body with pitch and pasting roofing paper over this before pouring the lining. The pitch and paper burn out when the door is put into use, creating voids that leave the lining, consisting of several individual blocks, each sufficiently free to prevent the setting up of destructive stresses when the door flexes or becomes bowed.

ANOTHER problem recognized in early experiments was that of properly supporting and reinforcing the lining blocks. One solution was to design the door body to provide for holding the concrete without the use of reinforcing steel. A more recent design provides for supporting the lining by means of horizontal ledges of cast iron. In a new all-steel fabricated door, designed and built at Gary Works, seven 1-in. hooks, welded to the back plate, extend into the concrete to provide support. These hooks, like the ledges, are air-cooled through the metal door back. With this design of door and lining, refractory concrete only, and no metal, extends into the oven.

Numerous failures of linings made from small size aggregate led to experiments with increasing proportions of larger sizes. The results showed that, at least under our conditions, a liberal proportion of coarse aggregate ranging in size up to 2½ in. or more is decidedly beneficial. It was also found that best results were obtained only by the inclusion of a considerable proportion of finely ground material. These fines are necessary to achieve greatest density and impermeability in the concrete. It is believed that the fines react chemically with the high-alumina cement when subjected to high temperatures and by this reaction produce certain highly refractory minerals that increase the refractoriness of the matrix and, on crystallizing, add to the mechanical strength of the concrete.

***Experiments made at Gary Coke Works should prove of value to members of the oil industry, especially to those in refining.***

THE composition of the aggregate is an important consideration. Our experience indicates that clean, slag-free, used firebrick that has been severely burned provides better aggregate than does new brick. Old blast furnace brick has been found to be particularly satisfactory. Practically all firebrick undergoes more or less shrinkage when burned at high temperatures; hence, the use of aggregate derived from reburned bricks in refractory concrete prevents the development of internal stresses in high temperature service. This, in the case of at least some new brick, might be sufficient to promote disintegration of the concrete.

Particular attention is given to curing the concrete by keeping the surface wet with a fine spray as the setting progresses. Concrete-lined doors placed on cold ovens and heated up with the battery have proved to have the longest life. If the doors must be put on hot ovens, the practice is to let the linings air-set for 10 to 14 days and to charge the oven immediately after the door is placed so as to retard the flow of heat into the lining, thereby tempering it.

Although relatively small so far as quantity of cement used is concerned, one of the most helpful uses of Lumnite has been for patching around inspection and charging holes on the battery tops and for general use in keeping the entire top air and water tight. One of the most satisfactory uses has been in connection with ascension pipe linings. Here the refractory concrete linings give every indication of being permanent, although the rammed plastic materials burned out and required replacement. Recently, in making extensive oven repairs, we removed 35 refractory concrete-lined ascension pipes that had been in service for 10 years. They were found to be in excellent condition, although not one of them had ever been patched or repaired in any way.

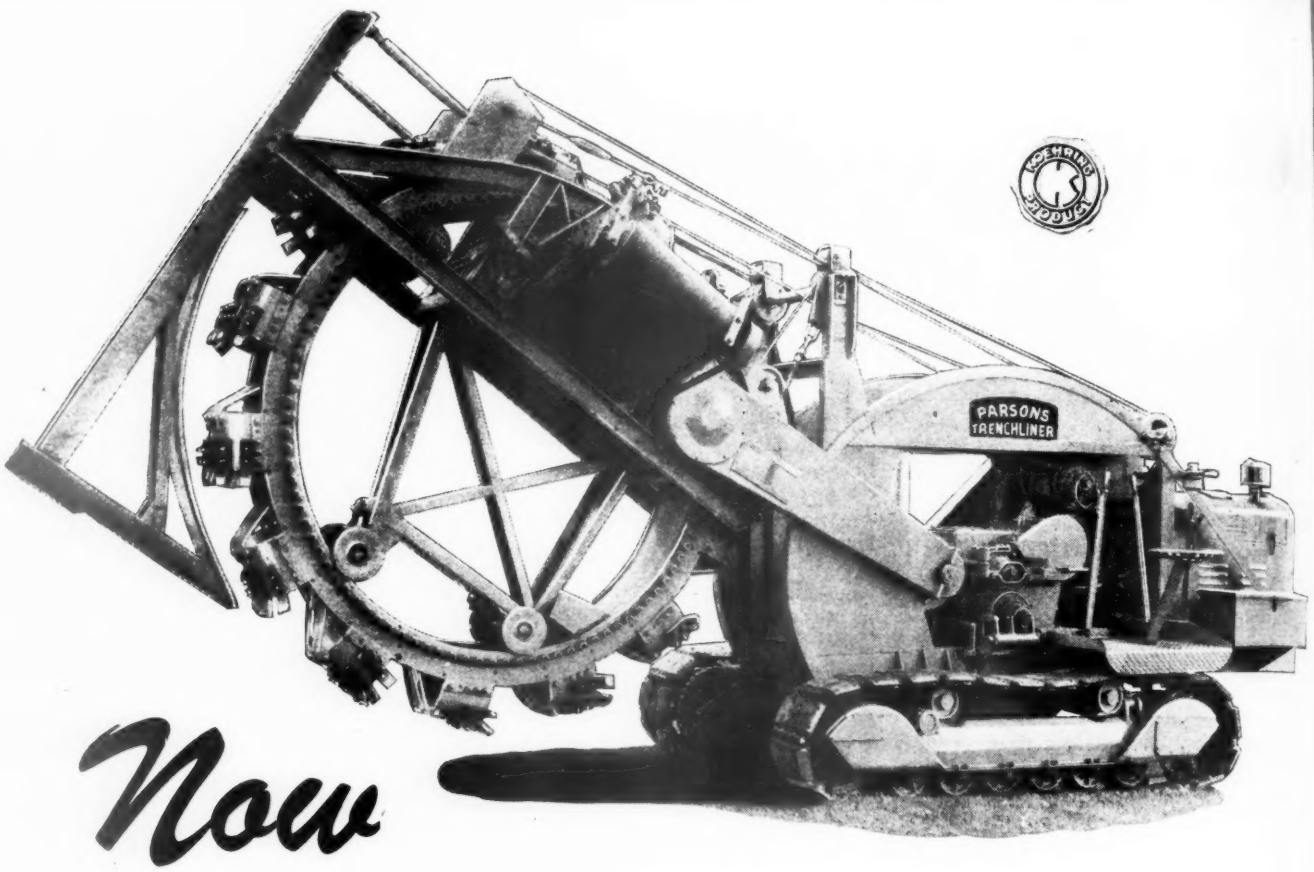
IN the construction of 9 large batteries of underjet ovens during a period of 10 years, the concrete slabs upon which the regenerator walls rest have been poured with refractory concrete. This was used to prevent the disintegration observed in the pads of earlier batteries that had been poured with Portland cement concrete. Lumnite refractory concrete has also been used successfully for sack flue linings and for the roof arches of waste gas canals in open hearth furnaces. Still another use has been for making heat insulating shields. These shields are made of angle iron and wire screen covered with a 3-in. thickness of paste consisting of Lumnite cement and shredded asbestos.

Considerable Lumnite has been used at Gary for repointing the linings of stacks carrying gases from waste heat flues, and for gunite linings in others. Where new brick linings were installed, the mortar for the joints was made with Lumnite. In these applications, it is important to use an aggregate that will be corrosion resistant. For mortar for joints, siliceous sand is used; for the gunite, either Haydite or trap rock screenings.

★ ★ ★

*Condensation of paper presented under the title "Development in the Use of Lumnite Cement at Gary Coke Works Plant," before Blast Furnace Coke Oven Association of the Chicago District, May 22, 1945.

†Subsidiary of United States Steel Corporation.

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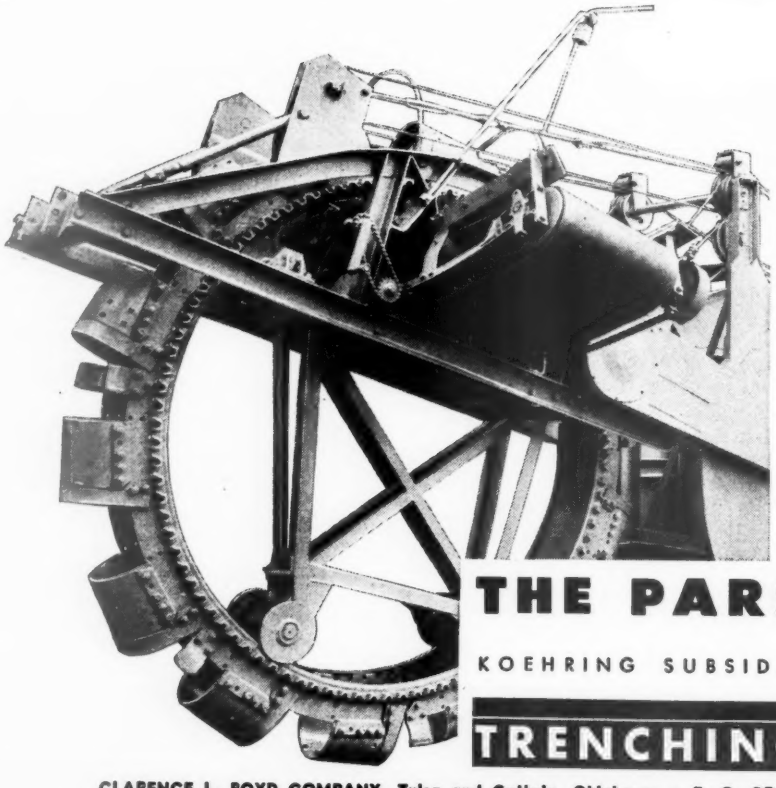

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# SELECTION OF GAS DEHYDRATION

By **A. RUSSELL YOUNG,** *Manager Natural Gas Division,* J. F. Pritchard and Company

**EXCLUSIVE** WITH the current trend of gas pipe lines to operate in excess of 300-350 lb. per sq. in gage, the need for gas dehydration to maintain maximum economical capacities has become apparent. The selection of the correct type of dehydration, however, has not always been given proper consideration.

The first consideration of course is the actual need for dehydration and the extent to which it should be carried. Every pipe line will offer its own peculiar problem, but the engineer should satisfy himself on the following questions:

***Points on which to base selection of the gas dehydration that will maintain maximum economical capacities.***

1. What is the minimum gas temperature that will be encountered below which the gas dew point must be maintained?
2. What would be the effect of the gas temperature falling below its dew point in the pipe line? Would this condition merely drop out water in the line, or tend to form gas hydrates and freeze up?
3. What is the water content of the gas entering the system? The outlet water content cannot exceed that entering, and the dew point following compression may not be equal to a saturated gas.

Fig. 1 shows the moisture content of natural gas at any given saturated temperature or pressure and the approximate melting point of gas hydrates. For any given change in these conditions, such as drop in temperatures of gas in pipe lines, the water-carrying capacity of the gas is reduced and the difference in water necessarily must drop out in the line.

Fig. 2 shows a study made of a typical pipe line operating on the discharge of a compressor station as is usual in most dehydration plant installations. The gas is cooled at the compressor station outlet in a cooling tower the daily minimum and maximum temperatures of which follow generally the daily air temperatures. In this study, the station outlet gas

FIG. 1. WATER CONTENT OF NATURAL GAS

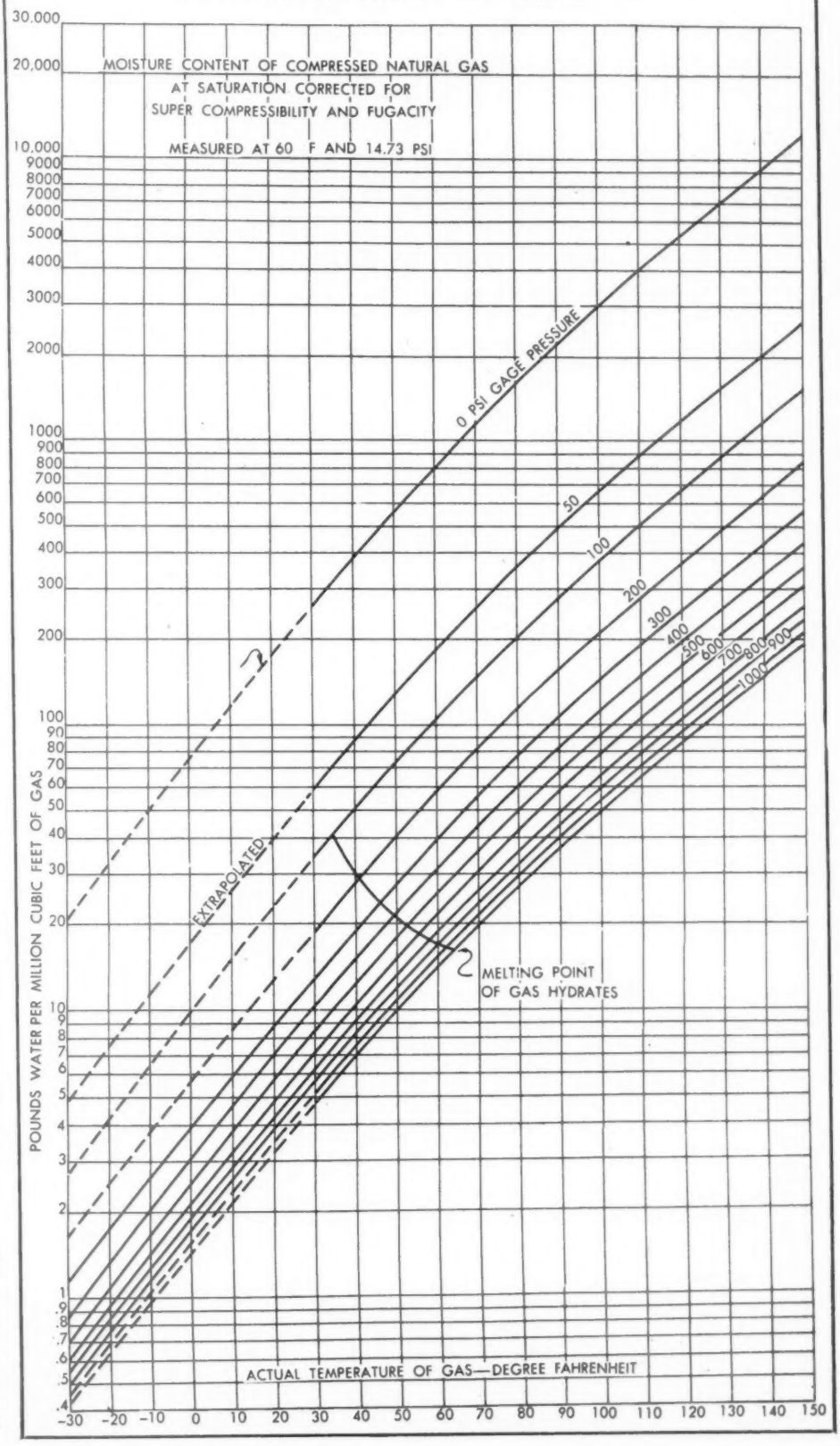
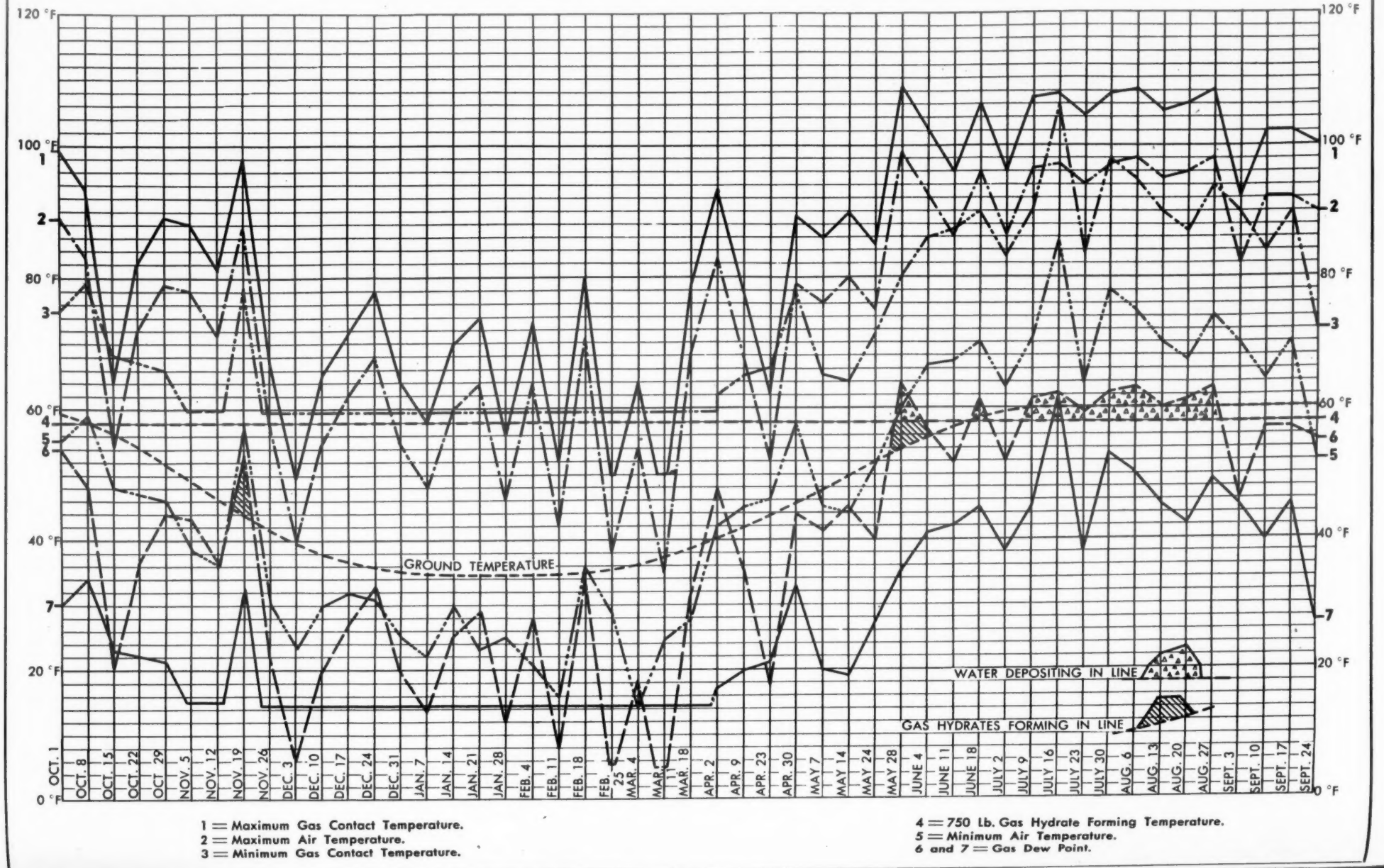


FIG. 2. DEW POINT GROUND TEMPERATURE.




1 = Maximum Gas Contact Temperature.
2 = Maximum Air Temperature.
3 = Minimum Gas Contact Temperature.

4 = 750 Lb. Gas Hydrate Forming Temperature.
5 = Minimum Air Temperature.
6 and 7 = Gas Dew Point.

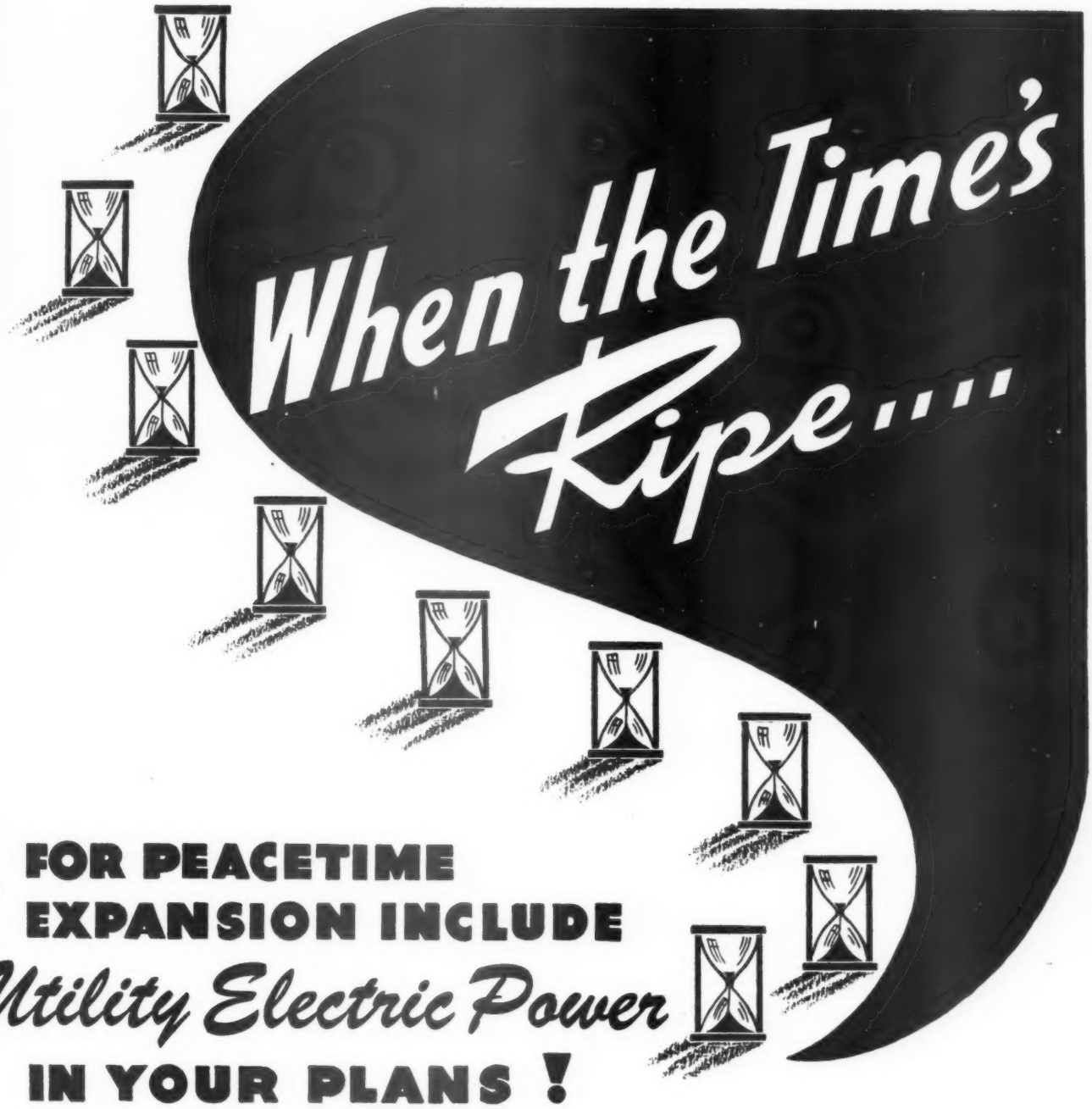



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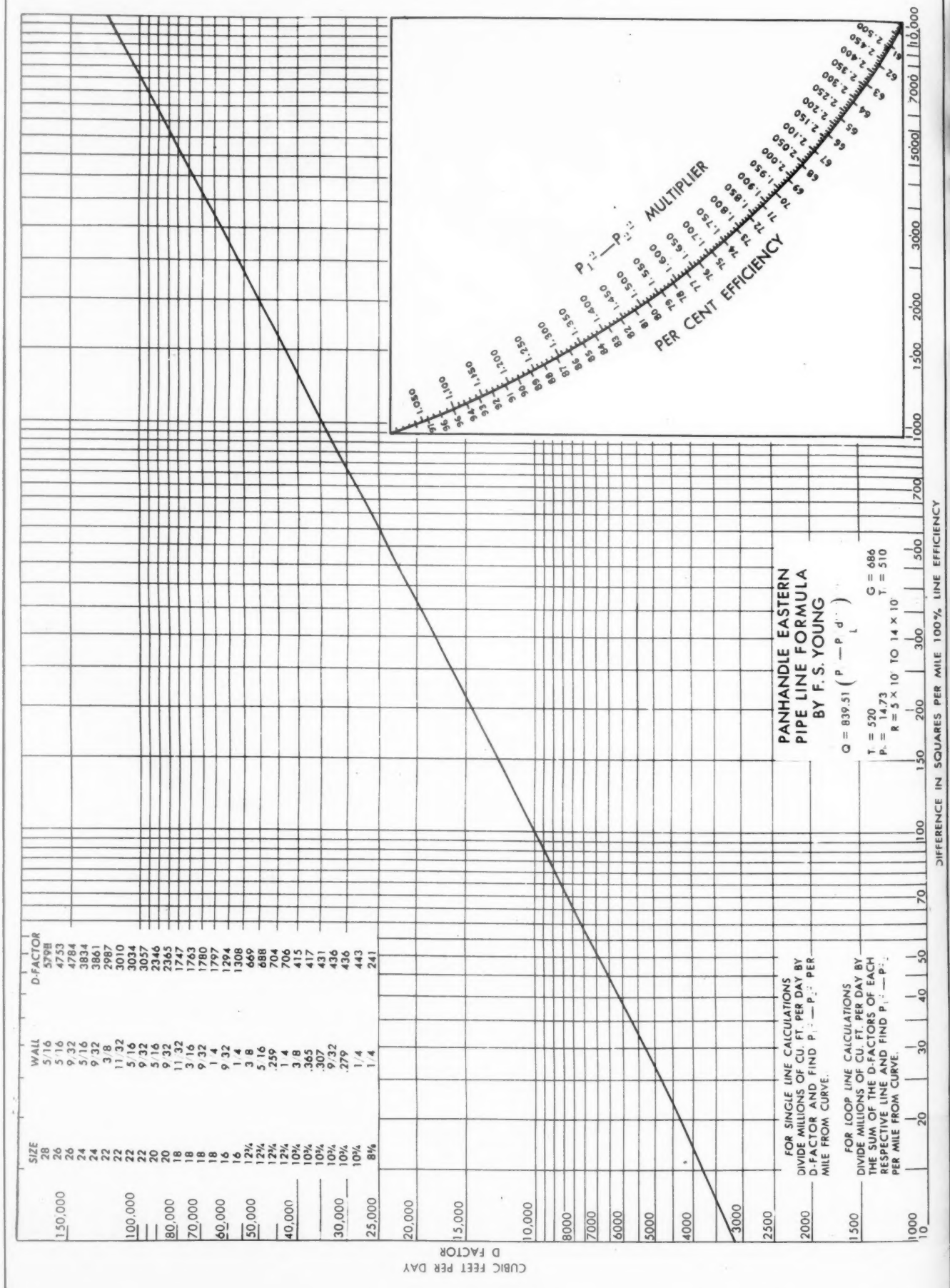
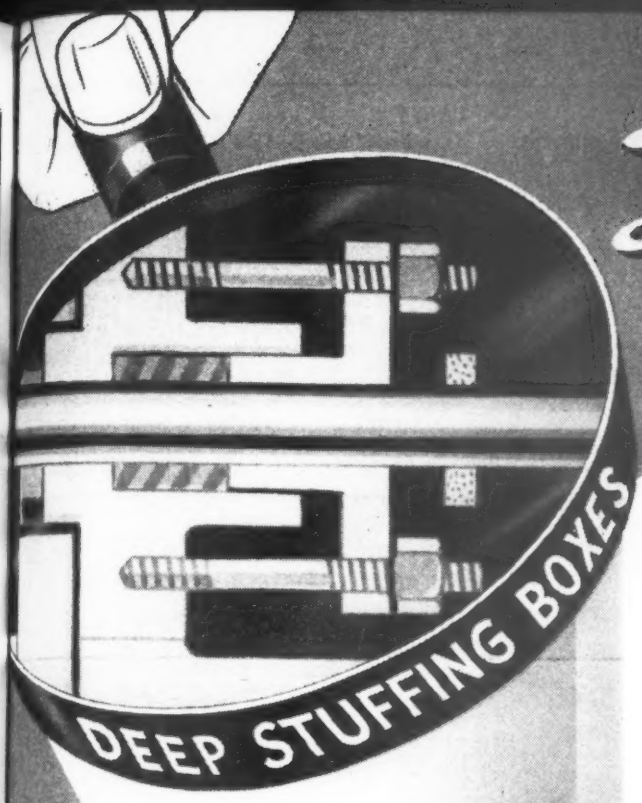
FIG. 3. PIPE LINE FLOW CHART.


SIZE
WALL
D-FACTOR
28 5/16 5798
26 5/16 4753
26 9/32 4784
24 5/16 3834
24 9/32 3861
22 3/8 2987
22 11/32 3010
22 5/16 3034
22 9/32 3057
20 5/16 2346
20 9/32 2365
18 11/32 1747
18 3/16 1763
18 9/32 1780
18 1/4 1797
16 9/32 1294
16 1/4 1308
12¾ 3/8 669
12¾ 5/16 688
12¾ .259 704
12¾ 1/4 706
10¾ 3/8 415
10¾ .365 417
10¾ .307 431
10¾ 9/32 436
10¾ .279 436
10¾ 1/4 443
8⅝ 1/4 241
CUBIC FEET PER DAY
D FACTOR
FOR SINGLE LINE CALCULATIONS
DIVIDE MILLIONS OF CU. FT. PER DAY BY D-FACTOR AND FIND P1² — P2² PER MILE FROM CURVE.
FOR LOOP LINE CALCULATIONS
DIVIDE MILLIONS OF CU. FT. PER DAY BY THE SUM OF THE D-FACTORS OF EACH RESPECTIVE LINE AND FIND P1² — P2² PER MILE FROM CURVE.
PANHANDLE EASTERN PIPE LINE FORMULA BY F. S. YOUNG
Q = 839.51 (P1² — P2²)^0.5 / L^0.5
T = 520
P1 = 14.73
R = 5 × 10⁷ TO 14 × 10⁷
G = 686
T = 510
P1² — P2² MULTIPLIER
PER CENT EFFICIENCY
DIFFERENCE IN SQUARES PER MILE 100% LINE EFFICIENCY

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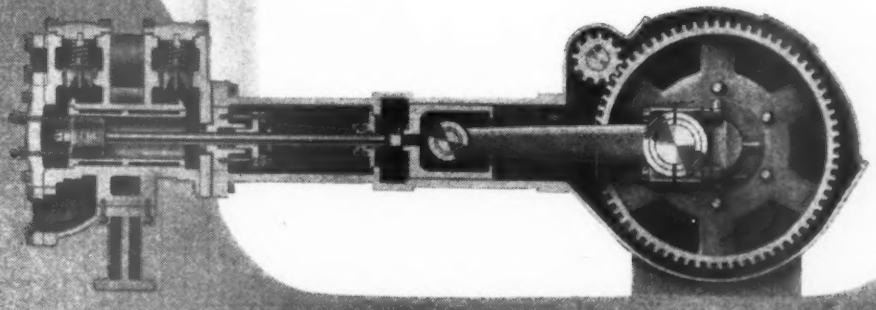
- Alloy Steel Lapped Herringbone Gears



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DIFFERENCE IN SQUARES PER MILE 100% LINE EFFICIENCY
945

has been contacted with a diethylene glycol solution resulting in an outlet dew point 45 to 50°F. below the gas contacting temperatures.

The gas in the pipe line, after flowing approximately 10 miles from the station, approaches the ground temperature plot. This ground temperature plot represents the first consideration—minimum temperature—to protect against. It should be noted that the maximum gas dew point line on a number of days is above the ground temperature line, which results in a possible condensation of water from a saturated gas. It is appreciated that under actual conditions, the gas flowing temperature will never reach ground temperature, but it is well to consider this as the minimum in order to allow for operating safety.

This leads to the second consideration, which is the effect of gas operating below its dew point. In the study shown by Fig. 2, the 750-lb. gas hydrate line has been plotted. When the temperature of the gas drops below the dew point and below the hydrate line (shown cross hatched) gas hydrates tend to form in the pipe line, whereas free drops of water tend to form just above the hydrate line (shown dotted).

If temperature conditions of a gas system are such that the hydrate point is never reached, the problem involves only the effect on pipe line efficiency of water collecting in sags in the line. Many pipe lines are so amply supplied with drips and blow-offs that this does not present a major operating or cost problem. In fact, the labor required to operate a dehydration unit could exceed the labor required to keep the pipe line blown clean. In new or old lines without adequate facilities, however, the cost of these drips and their maintenance should be considered against the cost of dehydration. Lines operating at high efficiencies during seasons when water drops out are often considerably affected by this water accumulation. One major pipe line experienced 5 to 10 per cent efficiency increase after these lines had been in operation with dehydration for several months. This evaluation of the possible effect on pipe line efficiency is peculiar to the individual system. From the accompanying pipe line flow curve, Fig. 3, the effect on volumes or pressures for small efficiency changes can be readily determined.

In view of continually rising pipe line operating pressures, it will be found that the flowing temperatures of gas under most conditions fall below the hydrate line during the winter seasons. The dew point of the gas necessarily must be maintained 5 or 10 deg. below this for safe operation, or about equal to ground temperature. With the exception of the solid adsorbents, other normal dehydrating agents are dependent on, and relative to, the contacting temperature with the gas to be dried. Typical results of the commonly used agents are as follows:

*(Continued on Page 143)*

**TABLE 1**

**Capacity: 30,000,000 std. cu. ft. natural gas per 24 hr. at 85°F. and 400 lb. per sq. in. gage.**

| | Type plant | |
|---|---|---|
| | 95 per cent diethylene glycol liquid solution | Solid adsorption unit |
| Water removed | 61 lb. per 1000 std. cu. ft. gas | 72 lb. per 1000 std. cu. ft. gas |
| Outlet dew point | 35 to 40°F. | Below —20°F. |
| Pressure drop | 2-5 lb. | 7-10 lb. |
| Operation | Continuous | Basis 8-hr. cycles |
| Initial cost (complete with utilities) | $49,865.00 | $67,175.00 |
| Cost 1000 std. cu. ft. gas treated (basis 10-yr. amortization) | 0.00045 | 0.00061 |
| Taxes, interest, insurance | 0.00020 | 0.00030 |
| Operating labor, upkeep, fuel | 0.00122 | 0.00122 |
| Glycol or adsorbent expense | 0.00017 | 0.00007 |
| Dehydration cost per 1000 std. cu. ft. natural gas treated | $0.00204 | $0.00220 |

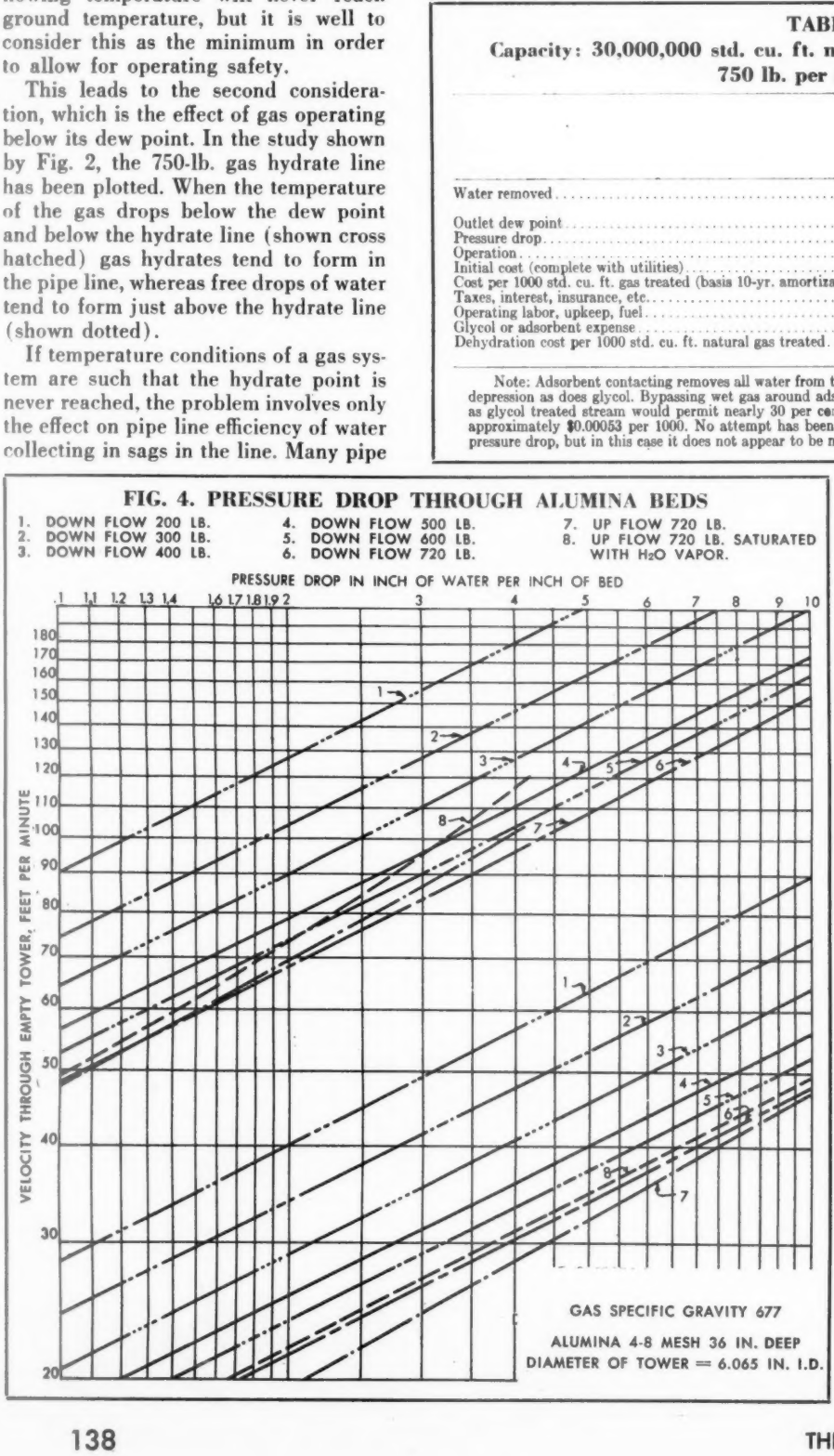
**TABLE 2**

**Capacity: 30,000,000 std. cu. ft. natural gas per 24 hr. at 85°F. and 750 lb. per sq. in. gage.**

| | Type plant | |
|---|---|---|
| | 95 per cent diethylene glycol liquid solution | Solid adsorption unit |
| Water removed | 32 lb. per 1000 std. cu. ft. gas | 42 lb. per 1000 std. cu. ft. gas |
| Outlet dew point | 35 to 40°F. | Below —20°F. |
| Pressure drop | 2 to 5 lb. | 7 to 10 lb. |
| Operation | Continuous | Basis 8-hr. cycles |
| Initial cost (complete with utilities) | $141,860.00 | $343,015.00 |
| Cost per 1000 std. cu. ft. gas treated (basis 10-yr. amortization) | 0.00013 | 0.00031 |
| Taxes, interest, insurance, etc. | 0.00006 | 0.00015 |
| Operating labor, upkeep, fuel | 0.00020 | 0.00020 |
| Glycol or adsorbent expense | 0.00017 | 0.00004 |
| Dehydration cost per 1000 std. cu. ft. natural gas treated | $0.00056 | $0.00070 |

Note: Adsorbent contacting removes all water from the gas treated instead of a quantity relative to dew point depression as does glycol. Bypassing wet gas around adsorbers until reaching approximately same water content as glycol treated stream would permit nearly 30 per cent overload of adsorbent plant, reducing treating cost to approximately $0.00053 per 1000. No attempt has been made to evaluate carefully the cost of added adsorbent pressure drop, but in this case it does not appear to be more than $0.00003 per 1000.

**FIG. 4. PRESSURE DROP THROUGH ALUMINA BEDS**


1. DOWN FLOW 200 LB.
2. DOWN FLOW 300 LB.
3. DOWN FLOW 400 LB.
4. DOWN FLOW 500 LB.
5. DOWN FLOW 600 LB.
6. DOWN FLOW 720 LB.
7. UP FLOW 720 LB.
8. UP FLOW 720 LB. SATURATED WITH H2O VAPOR.
PRESSURE DROP IN INCH OF WATER PER INCH OF BED
VELOCITY THROUGH EMPTY TOWER, FEET PER MINUTE
GAS SPECIFIC GRAVITY 677
ALUMINA 4-8 MESH 36 IN. DEEP
DIAMETER OF TOWER = 6.065 IN. I.D.

*(Continued from Page 138)*

Solid adsorbents . . .

| Agent | Dew point depression below contact temperatures |
|---|---|
| 35% $CaCl_2$—water sol. | 20°F. |
| $CaCl_2$—glycerin—water sol. | 30°F. |
| 95% glycol water sol. | 45-50°F. |

Water removal to below — 20°F. for capacity of bed.

Typical temperature of compressor station aftercooler gas, as shown on Fig. 2, varies to an upper limit as the air or air wet bulb temperature changes. The lower limit of gas cooling is its hydrate point. The difference between this seasonal contact gas temperature and the minimum gas flowing temperature in the pipe line is the least dew point depression allowable. The selection of any dehydrating solution should give depressions at least 5 deg. below calculated minimum line temperatures.

When two or more types of dehydration will meet requirements, the final selection naturally is contingent on their respective economy. The selection for most plants today lies between the use of the glycol solution and the solid adsorbents.

Where glycol solutions will meet the dew point requirements, it is generally found they are more economical in initial installations. Once placed in operation, they run on a continuous cycle requiring minimum operating attendance.

The solid adsorbents provide the only answer to many of the high pressure-low dew point needs. Units in continuous operation have used successfully the same adsorbent charge for years. They are not the answer for all dehydration problems, however. It is advisable to obtain a gas analysis and study the gas carefully before installing solid adsorbents in new fields. Test units should be set up and operated before using solid adsorbents on gases containing $H_2S$ and $O_2$ in any quantities, on gases containing heavy ends such as in natural gas mixed with coke-oven gases, or on gases containing excess liquids or distillates.

One of the main problems of the solid adsorbent lies in its overall plant pressure drop. Fig. 4 shows typical bed drops, and it is difficult to design an economical unit with much less than 7 to 10 lb. drop against approximately a 2 to 5 lb. drop in the liquid solution type plant.

For comparisons between the glycol and solid adsorbents, Tables 1 and 2 tabulate costs of treating 30,000,000 standard cu. ft. of natural gas per 24 hr. at pressure of 400 lb. per sq. in. gage and temperature of 85°F.; and 300,000,000 standard cu. ft. per 24 hr. at 750 lb. per sq. in. gage and 85°F. Costs include all utilities with units amortized over a 10-year period. Glycol make-up has been assumed on an average of 0.075 gal. per million standard cubic feet of gas treated and solid adsorbent has been estimated on basis of two complete charges for the 10-year period. ★ ★ ★


# Keep down Production Costs with

**Tight Valves** ON AIR, STEAM, AND WATER LINES

**Efficient Lubrication** OF BEARINGS

Fig. 123, "N-M-D" Globe Valve 150 lb. S. P.

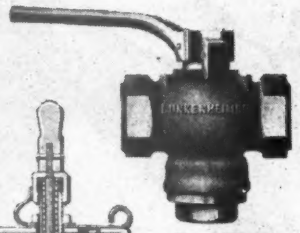


Fig. 1571 Air Cock 150 lb. Pressure

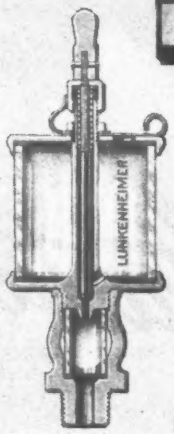


Fig. 1300 "Sentinel" Oil Cup with Sight Feed

Fig. 1815 Bottle Oiler

Fig. 1834 "Alvor" Constant Level Oil Control

Leaky valves, permitting the escape of steam, air, or water, are wasteful in themselves—doubly wasteful in their effect on production costs and operating efficiency.

Inadequate, hand-method lubrication is another cost booster . . . increasing expense of machinery repair, of lubricant, of inspection time.

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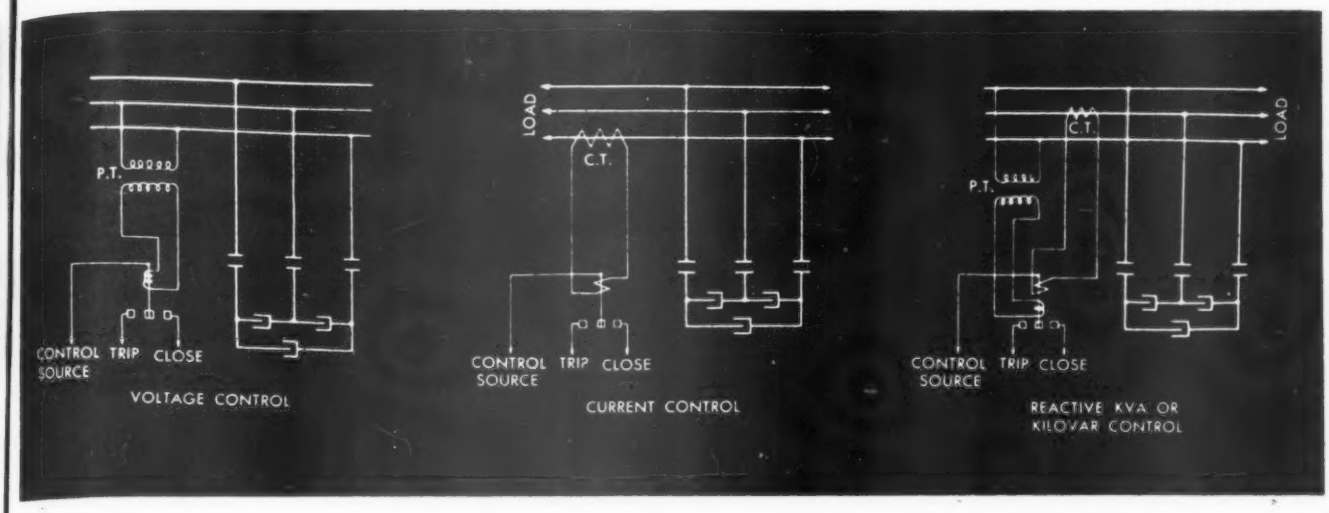



**FIG. 1. Voltage control, current control, and kvar control methods of automatically switching capacitors illustrated schematically.**

# AUTOMATIC SWITCHING OF SHUNT CAPACITORS

By **W. H. CUTTINO,** *Capacitor Engineer, Switchgear Engineering Department*
Westinghouse Electric Corporation

CAPACITORS have made it possible to supply large increases in load with existing power facilities. This addition of capacitors to release system capacity has played an important role during the present war with its shortage of materials and labor. When more and more capacitors are added to a system, however, a situation is reached where their effect becomes objectionable during certain operating conditions. It is, therefore, desirable to obtain the benefits of additional capacitor correction without the objectionable aspects.

A relatively small capacitor may be connected to a circuit with very little effect upon the performance of the circuit. As the size of the capacitor increases, the addition or removal of the capacitor has an increasing effect upon the circuit voltage, line current, line losses, and circuit power factor. The line losses are at a minimum when the capacitor kilovars are the same as the load kilovars. The maximum benefits, therefore, are obtained by switching the correct size capacitors at the appropriate time. Because of the large increase in the use of shunt capacitors within the last few years, the power systems are rapidly approaching the point where capacitors must be switched automatically in order to obtain the maximum benefits of capacitor correction.

● **Methods of switching capacitors.** Capacitors may be switched manually with variation in load provided a reliable attendant is available to observe the operating conditions such as voltage, kvar, etc., and perform the desired switching operations.

If it is found desirable to switch capacitors with variation in load, consideration should be given to distributing the capacitors out on the circuit and connecting them directly to the motor terminals to be switched "off" and "on" with the motor without additional switching equipment. The size of the capacitor switched with the motor switch should be selected to avoid excessive overvoltage due to self-excitation. In some cases it may be desirable to use a separate switch for the capacitor and let the motor initiate the opening and closing of the capacitor switch.

A time switch may be used to initiate the switching operations in some cases provided the load variation follows a repetitive load pattern each week.

Capacitors may switched automatically in response to changes in load. The three generally accepted methods of switching are:

1. Voltage control
2. Current control
3. Kvar control.

● **Application of automatic control equipment.** The switching of capacitors may be desired to prevent overvoltage, improve voltage regulation, reduce line current, to keep the demand low in proportion to the kilowatt loading or keep the overall power factor within desired limits to maintain minimum cost of power purchased under certain rate schedules.

In deciding whether the capacitors should be switched automatically, consideration should be given to the size of the capacitor banks, the extent to which the kilowatt and kilovar load varies over a typical load period, the variation of voltage with load, and benefits desired. In making an analysis, it is usually desirable to make measurements of kilovars, kilowatts, and voltage over a typical load period to determine the capacitor kilovar requirements and then if automatic switching is needed to determine what type of control would be best suited for actuating the switching device.

When objectionable voltage variations occur with varying loads, the voltage control shown schematically at the left in Fig. 1 should be considered. If the principal reason for switching the capacitors is to avoid overvoltages on lamps and motors during light load periods, the requirements usually can be met by using a single step voltage control that disconnects the capacitor bank when the voltage rises above a certain value and reconnects it when the voltage falls below a predetermined level.

This single step voltage control is especially useful in a plant where a number of induction motors are switched off during rest periods or at night. As the motors are shut down, the voltage control disconnects the capacitor bank to keep the voltage from rising too high. As the motors are switched on again, this process is reversed to keep the voltage from falling below normal.

If voltage regulation is the primary objective of the capacitor switching installation a multi-step voltage control is usually required to hold the circuit voltage within the set limits. The multi-step control is particularly useful on the longer distribution circuits and plant feeders that extend some distance beyond the voltage regulators. Unlike the ordinary voltage regulator, however, the capacitor bank with multi-step voltage control improves the voltage regula-

tion on both the supply and the load side of the bank by reducing the current flowing in the supply feeders. This is accomplished without changing the existing regulating equipment and lowers the IX and IR losses in the circuit. If the voltage change produced by the capacitor is greater than the difference between maximum and minimum desired voltage limits then multi-step voltage control should be used. Fig. 3 illustrates graphically a case where one-half the capacitors produce a voltage change less than the difference between the desired upper and lower voltage limits. For this situation two switched capacitor banks and a two step voltage control are used to obtain satisfactory voltage regulation.

If the load with which the capacitors are associated is small in comparison with the total load on the circuit, then the addition or removal of the capacitor bank will have little effect on the circuit voltage. In this case the voltage control may cause the capacitors to be switched independently of load. If the capacitors are connected to a well regulated bus the voltage regulators or other devices will usually keep the voltage within satisfactory limits independently of the amount of capacitors applied. Circuit voltage therefore does not necessarily reflect the need for capacitors and if capacitors are to be switched other methods of detecting their requirements should be used.

For example, if sufficient capacitors are added to supply the lagging kvar at full load it may be desirable to switch them with variations in load to reduce the demand and losses or avoid a penalty because of excessive leading power factor at light load. Sometimes capacitors are installed so that regulating equipment can maintain a satisfactory voltage level at full load. In such cases the capacitors usually should be removed at light load in response to kvar control or current control so that the regulator will be operating under the best conditions to keep the voltage within satisfactory limits.

The choice between current and kvar control depends upon the relationship of load power factor to variation in kilowatt loading, the number of switching steps required and the existing physical circuit arrangement. In cases where either type of control can be used the physical arrangement of the circuit and availability and location of instrument transformers will dictate the type of control to be selected. The current control master element should receive its signal from a current transformer situated on the load side of the capacitor to measure the uncorrected load whereas the current transformer for signaling the current element of the kvar relay should be located on the supply side of the capacitor.

Where the voltage is well regulated and the load power factor remains substantially constant with variation in kilowatt loading, the current control scheme shown in the center of Fig. 1 is usually used.

On circuits where the voltage is well

**FIG. 2. Graphic illustration of voltage regulation by means of single step switching in response to changes in circuit voltage.**

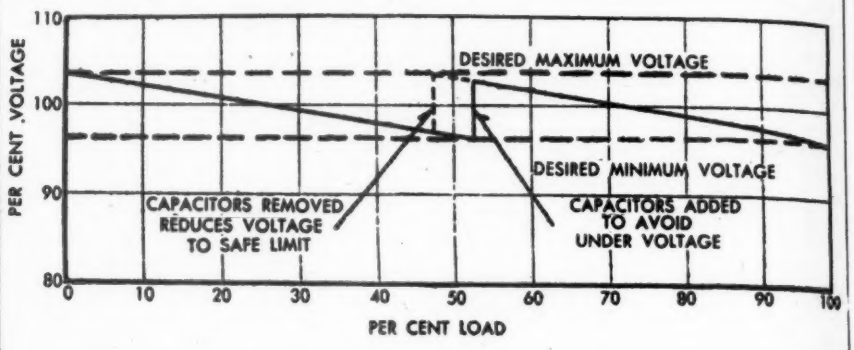



**Fig. 3. Graphic illustration of voltage regulation by means of multi-step switching in response to changes in circuit voltage. As load increases the voltage drops and capacitors are added selectively at A and B to boost voltage. As load drops and voltage rises capacitors are removed selectively at B′ and A′ to reduce voltage.**

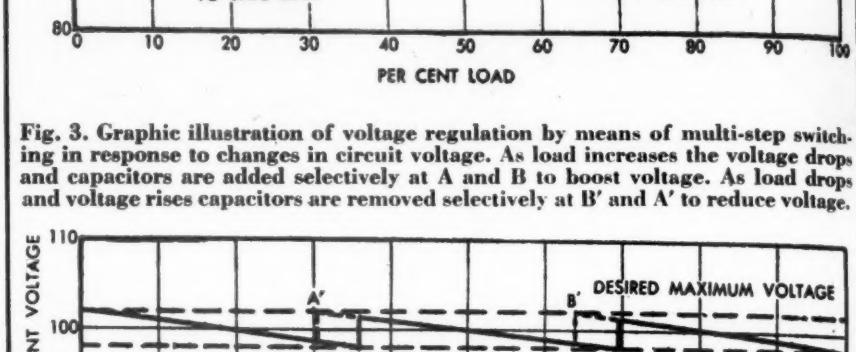
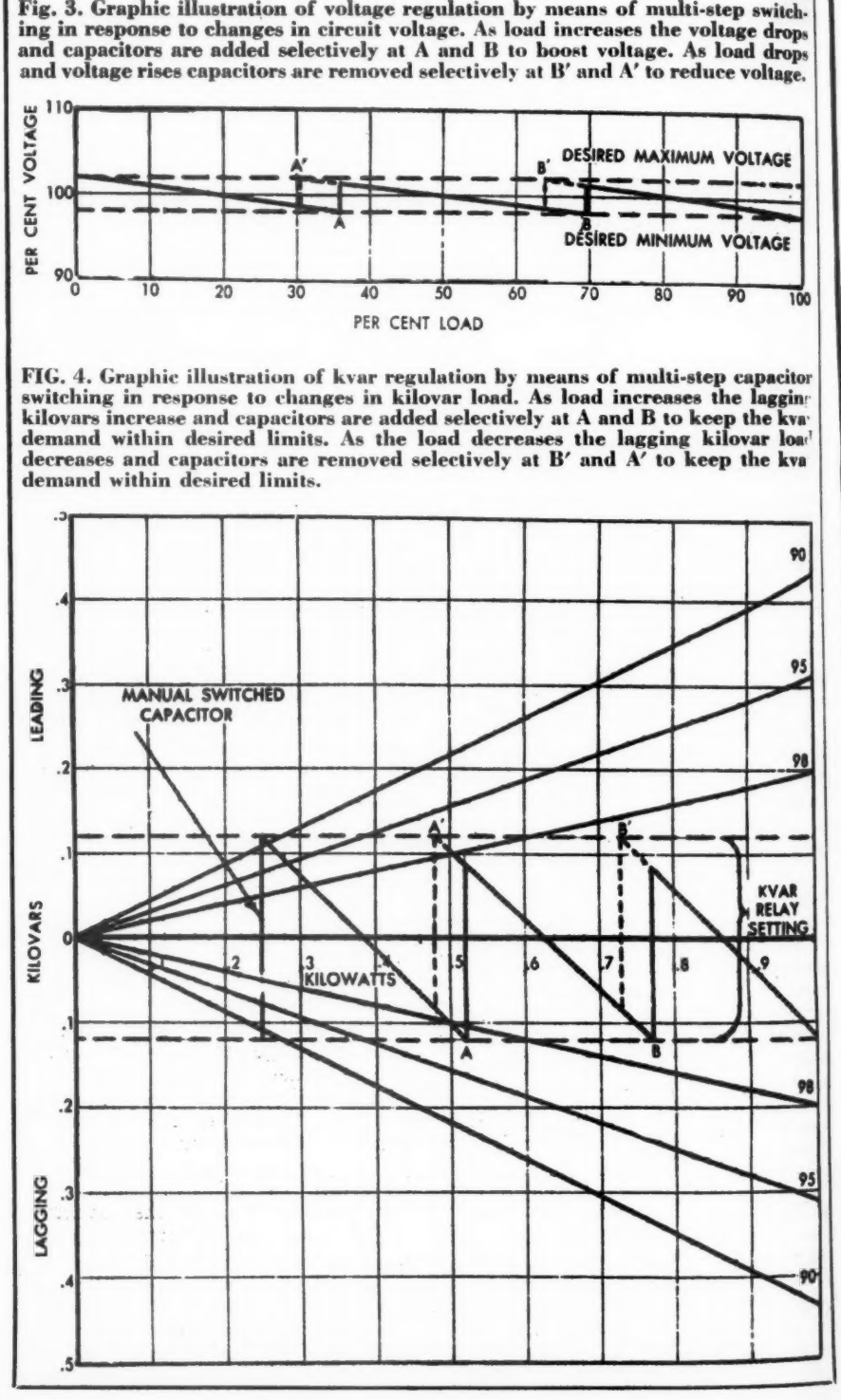



**FIG. 4. Graphic illustration of kvar regulation by means of multi-step capacitor switching in response to changes in kilovar load. As load increases the lagging kilovars increase and capacitors are added selectively at A and B to keep the kva demand within desired limits. As the load decreases the lagging kilovar load decreases and capacitors are removed selectively at B′ and A′ to keep the kva demand within desired limits.**



regulated and the load power factor varies in an unpredictable manner with variation in kilowatt loading the kvar control shown in schematic form at the right in Fig. 1 gives the best results.

Fig. 4 illustrates graphically how the kvar demand was kept within desired limits at an industrial plant where it was desired to improve the full load power factor from 70 per cent to 97 per cent lagging. In this case the load power factor was expected to vary in an unpredictable manner between 60 per cent and 80 per cent for load variations between one-fourth and full load.

By adding sufficient capacitor kilovars to improve the power factor from 70 to 98½ per cent and having about one-third fixed with the remaining divided into two steps of about one-third each the kvar demand was kept within desired limits.

● **Necessary components.** The automatically switched capacitor installation consists of the capacitor, the capacitor switch, the automatic control, instrument transformers, and control source.

These components can be assembled in combinations that will meet almost any operating requirement. Rack type capacitor units are available for either indoor or outdoor service. The capacitor switch and automatic control may be assembled in the capacitor housing or the capacitor switch and the control may be mounted separately from the capacitor. If it is desirable to have the control elements at some central location, the automatic control assembled in a cabinet can be mounted separately from the capacitor or capacitor switch. This latter arrangement is often used with indoor multiple unit dust-tight capacitor assemblies and outdoor hanger type capacitor units mounted on poles.

The automatic control that receives and interprets the signal and acts to perform the desired function consists of a master relay, time delay relays, auxiliary devices, and a control switch. A voltage sensitive relay, a current sensitive relay, or a kilovar sensitive relay is the master element. It receives and interprets the signal and initiates the switching operations after a time delay sufficient to prevent unnecessary switching operations caused by momentary disturbances on the power circuit. The time delay usually is not critical but in the interest of keeping the transient inrush current to a minimum, enough delay is inserted between the opening and closing of the capacitor switch to permit the discharge devices to drain off a substantial part of the stored energy. Auxiliary relays respond to the request of the master element and time delay relay to close or open the capacitor switch and handle the heavier control currents that should not be handled by the sensitive control relays. The capacitor switches may open and close in response to the master element or they may be opened or closed manually by operation of their control switch.

Electrically operated circuit breakers generally used for switching the larger size capacitor banks have the advantage of providing over-current or fault protection in addition to the switching function. In some instances the capacitor switch may be required to switch the capacitor as much as 25 times per day, therefore the switch should be suitable for this duty and have the required momentary current and interrupting rating. Contactors may be adequate for small, low-voltage capacitors where the fault current or momentary inrush current does not exceed the maximum rating of the contactor. Oil immersed contactors may be used on small medium-voltage capacitors for distribution circuits on a similar basis.

The voltage sensitive relay for voltage control as illustrated at the left of Fig. 1 should receive its signal from a potential transformer situated at the point where the voltage is to be controlled, which may be on either side of the capacitor. The current control master element should receive its signal from a current transformer placed on the load side of

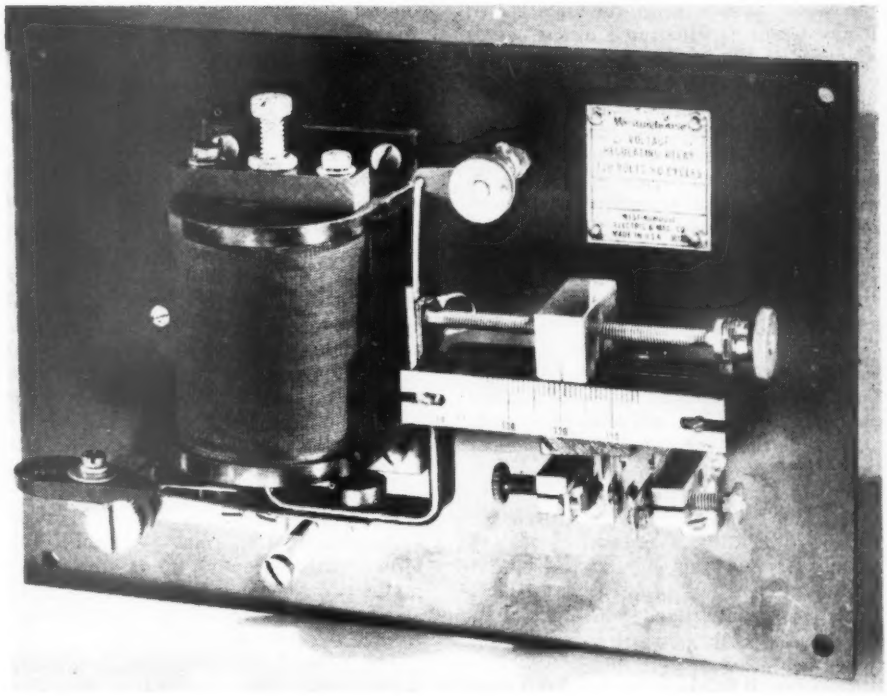


**FIG. 5. Voltage regulating relay used for initiating the automatic switching of shunt capacitors in response to change in circuit voltage.**

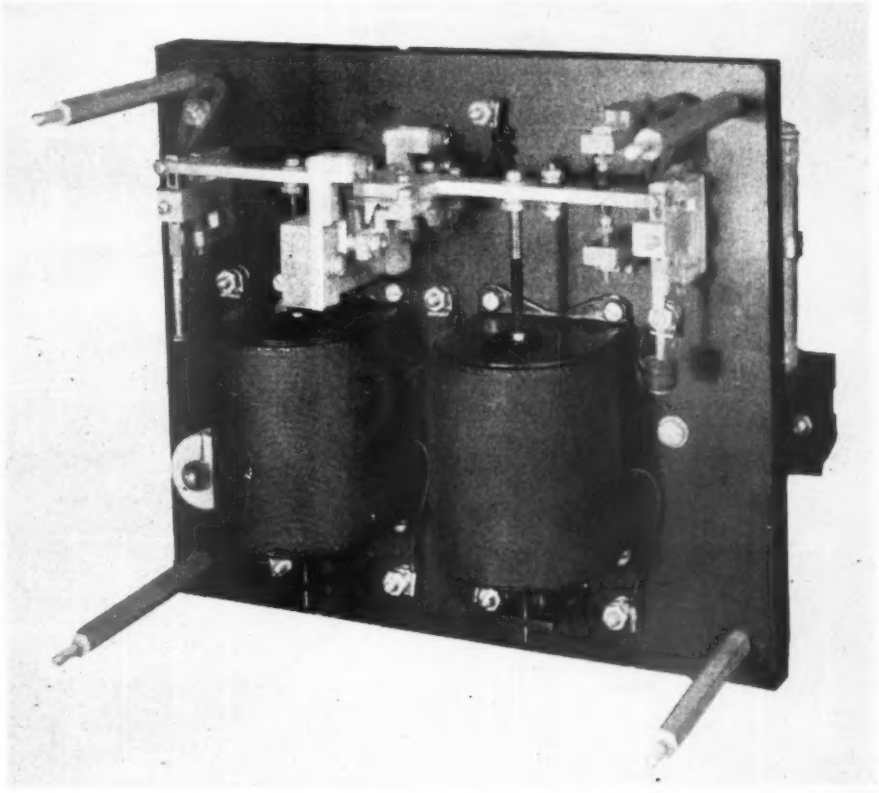


**FIG. 6. Kvar regulating relay used for initiating the automatic switching of capacitors in response to change in kvar demand.**

the capacitor to measure the uncorrected load current as illustrated in the center diagram of Fig. 1. The kvar control necessitates measuring the combination of both current and voltage and it is usually desired to measure the corrected load current. The current element of the master relay therefore should receive its signal from a current transformer situated on the supply side of the capacitor as shown in the right-hand diagram of Fig. 1. The voltage element can receive its signal from a potential transformer situated on either side of the capacitor.

"Range of adjustment" and "band width" must be given proper consideration on all regulating types of master elements. Range of adjustment is considered as the normal operating level of the device and it allows for the differences encountered in operating conditions. The band width is the difference between pick-up (contact closes to switch a capacitor on) and drop-out (contact closes to switch capacitor off). This band width must be larger than the signal change caused by switching the capacitor to prevent "pumping." For illustration, it might be pointed out that one of the conventional voltage regulating relays has a range of adjustment from 90 to 110 per cent of its normal rating of 115 volts. The band width of this relay is adjustable from 3 to 7.5 per cent of its normal rating.

Fig. 5 shows a simple voltage sensitive relay that is used to initiate the opening or closing of the capacitor switch in response to a change in circuit voltage. This is an alternating current, solenoid operated moving arm type of relay with moving contacts that travel between two stationary contacts with a permanent magnet for adjusting band width. The voltage range is adjustable by shifting the weight along the moving arm. The band width is adjustable by changing the position of the permanent magnet. The permanent magnet also provides quick "make" and quick "break" of the relay contacts. This type voltage regulating relay is suitable for either single step or multi-step automatic control for switching capacitors and has also been used on many feeder voltage regulators.

The current sensitive relay is similar to the voltage relay except it is equipped with an auxiliary transformer with taps to obtain wide range of adjustment. This transformer saturates to limit the voltage on the relay coil. A current relay is suitable for single step control only. If more than one switching step is desired, a separate current control is required for each capacitor switch. In this case the current sensitive relays should be adjusted for different current values to permit sequence switching operations.

A kvar sensitive relay is shown in Fig. 6. This is an alternating current solenoid operated moving arm type of relay having both potential and current windings with moving contacts that travel between two stationary contacts. When the power factor is unity the kilovars are zero and no torque is developed. If the phase angle between the current and voltage is shifted in the lagging direction indicating an increase in lagging kilovars, a torque proportional to the lagging kilovars is applied to rotate the movable arm in the clockwise direction. Leading kilovars produce a torque in the opposite direction. The lagging and leading kilovar band width is adjustable, as is the range of adjustment. Permanent magnets are used to obtain quick make and quick break of the relay contacts. This relay is suitable for either single step or multi-step automatic control for switching capacitors.

In the control circuits a certain amount of time delay is desirable to prevent unnecessary switching operations. This delay is obtained by a relay like that shown in Fig. 7 as devices 2 and 62. This two-element, thermal-type, time-delay relay times both the closing and opening of the capacitor switch. The thermal elements are connected with an insulating means to compensate for variation in ambient temperature to hold timing constant for a given relay setting.

A typical diagram illustrating single step kvar control with Rectox solenoid operated circuit breaker is illustrated in Fig. 7. Fig. 8 shows the control relays mounted on a control panel, which is enclosed in the capacitor housing. If the control switch is in the automatic posi-

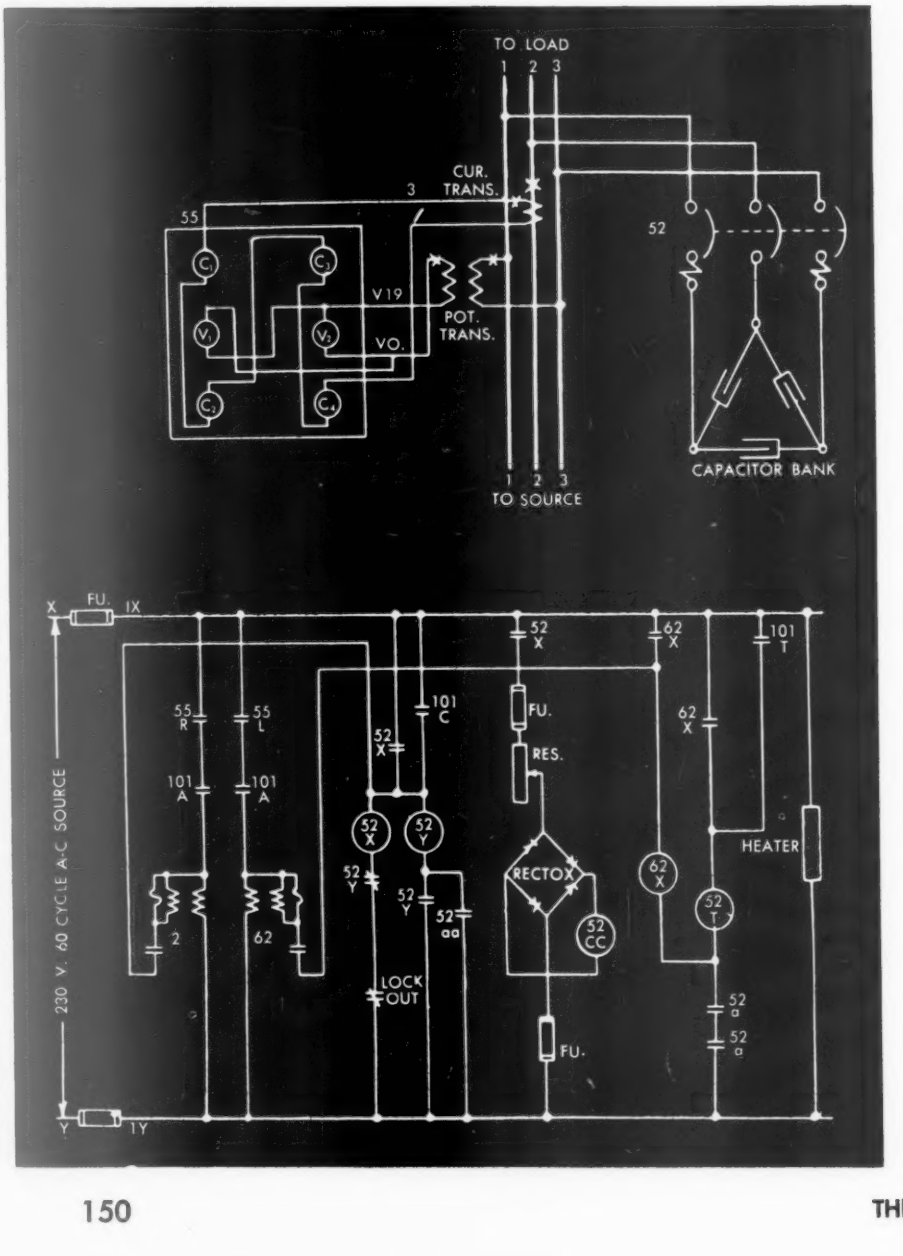



**FIG. 7. Schematic diagram of a typical single step kvar control with Rectox solenoid operated circuit breaker.**

**LEGEND**

| | |
|---|---|
| 2 and 62 | TIME DELAY RELAY |
| 52 | CIRCUIT BREAKER |
| 52 a | BREAKER AUXILIARY SWITCH CLOSES WHEN BREAKER CLOSES |
| 52 b | BREAKER AUXILIARY SWITCH OPENS WHEN BREAKER CLOSES |
| 52 aa | CUTOFF SWITCH CLOSES IN OPERATED POSITION OF MECHANISM |
| 52 cc | BREAKER CLOSING COIL |
| 52 T | BREAKER TRIP COIL |
| 52 X | TYPE "30 F2" CONTROL RELAY |
| 52 Y | TYPE "SG" CUTOFF RELAY |
| 55 | RKVA RELAY: R = RAISE, L = LOWER |
| 62-X | AUXILIARY TRIP. RELAY, TYPE "SG" |
| 101 | BREAKER CONTACT SWITCH: C = CLOSE, T = TRIP, O = OFF, M = MANUAL, A = AUTOMATIC. "A" IS CLOSED WHEN HANDLE IS PULLED OUT. "M" IS CLOSED IN NORMAL POSITION OF HANDLE. |

ALL DEVICES ARE SHOWN DEENERGIZED. PHASE ROTATION 1-2-3. CONTROL SWITCH CONTACTS "MAKE" IN POSITION INDICATED.

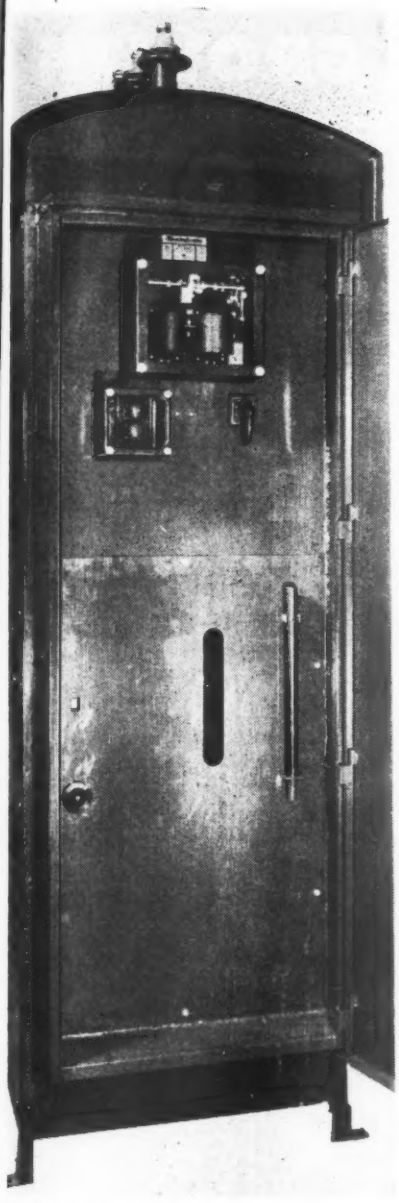


FIG. 8. Single step kvar control panel enclosed in outdoor capacitor rack showing kvar relay, time delay relay, and control switch.

tion and one set of the master element contacts closes, indicating that capacitor kvar is required, this will energize the closing element of the time delay relay. If the initial cause is not a temporary disturbance, then the master element contacts will remain closed until the time delay relay contacts have closed energizing the closing mechanism of the capacitor switch. The capacitor switch will then close and connect the capacitor to the circuit.

If with the capacitor connected to the circuit one set of the master element contacts closes, indicating that the capacitor correction should be removed, this energizes the tripping element of the time delay relay. If the master element contacts remain closed for the time required for the time delay tripping contacts to close, then the capacitor switch tripping device will be energized opening the capacitor switch and disconnecting capacitor from circuit.

The multi-step control operates in a manner similar to a single step control except it is arranged to switch two or more groups of capacitors selectively and automatically by means of relays.

● **Determination of capacitor kvar steps.** If it is found that the capacitors should be automatically switched the following steps are recommended in selecting the size and number of switching steps:

(a) Determine the maximum capacitor kvar permitted during light load condition without exceeding the upper voltage limits, to maintain desired power factor or to keep the reactive kvar demand within desired limits.

(b) Next determine the maximum capacitor kvar that can be switched in one operation without exceeding the permissible voltage limits, kvar demand or change in power factor.

(c) The difference between the total capacitor kvar installed and the capacitor permitted during light load determines the total capacitor kvar to be switched.

(d) The minimum number of switching steps is the ratio of the total capacitor kvar to be switched to the maximum capacitor kvar that can be switched in one operation without exceeding permissible limits.

For practical purposes the voltage drop can be determined from the kilowatt load component flowing through the resistance of the circuit plus the kilovar component flowing through the reactance of the circuit. The voltage rise produced by the capacitor is the product of the circuit reactance ohms and the change in kilovar load amperes provided by the capacitor. When calculating voltage rise produced by the capacitor above an existing voltage level, the non-linear variation of exciting kilovars drawn by motors, transformers, etc., should be given due consideration. If the voltage level is high, the exciting kilovars load may increase rapidly with small increase in voltage and should be taken into account in arriving at the net kilovars. It should also be kept in mind that the capacitor kvar varies as the square of the voltage for a given rating. If the voltage level is moderate and steps are taken to permit only a small change in voltage, the non-linear variation of exciting kilovars may be of no consequence and may be disregarded. If this is the case, the voltage rise produced by the capacitor is the product of the circuit reactance ohms and the capacitor current.

$$\text{Per cent voltage rise produced by capacitor} = \frac{\text{Capacitor kvar} \times \text{circuit reactance, ohms}}{10 \times (\text{line kilovolts})^2}$$

Not only are capacitors applied to improve circuit voltage, increase system capacity, reduce kvar demand, and improve power factor, but they are also used to reduce power costs. In the final analysis the capacitors are chosen because they are more economical than other methods of obtaining the desired improvements in circuit performance or reduction in power costs. ★★★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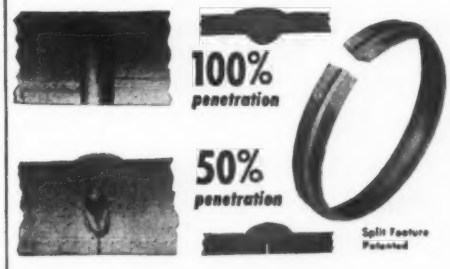


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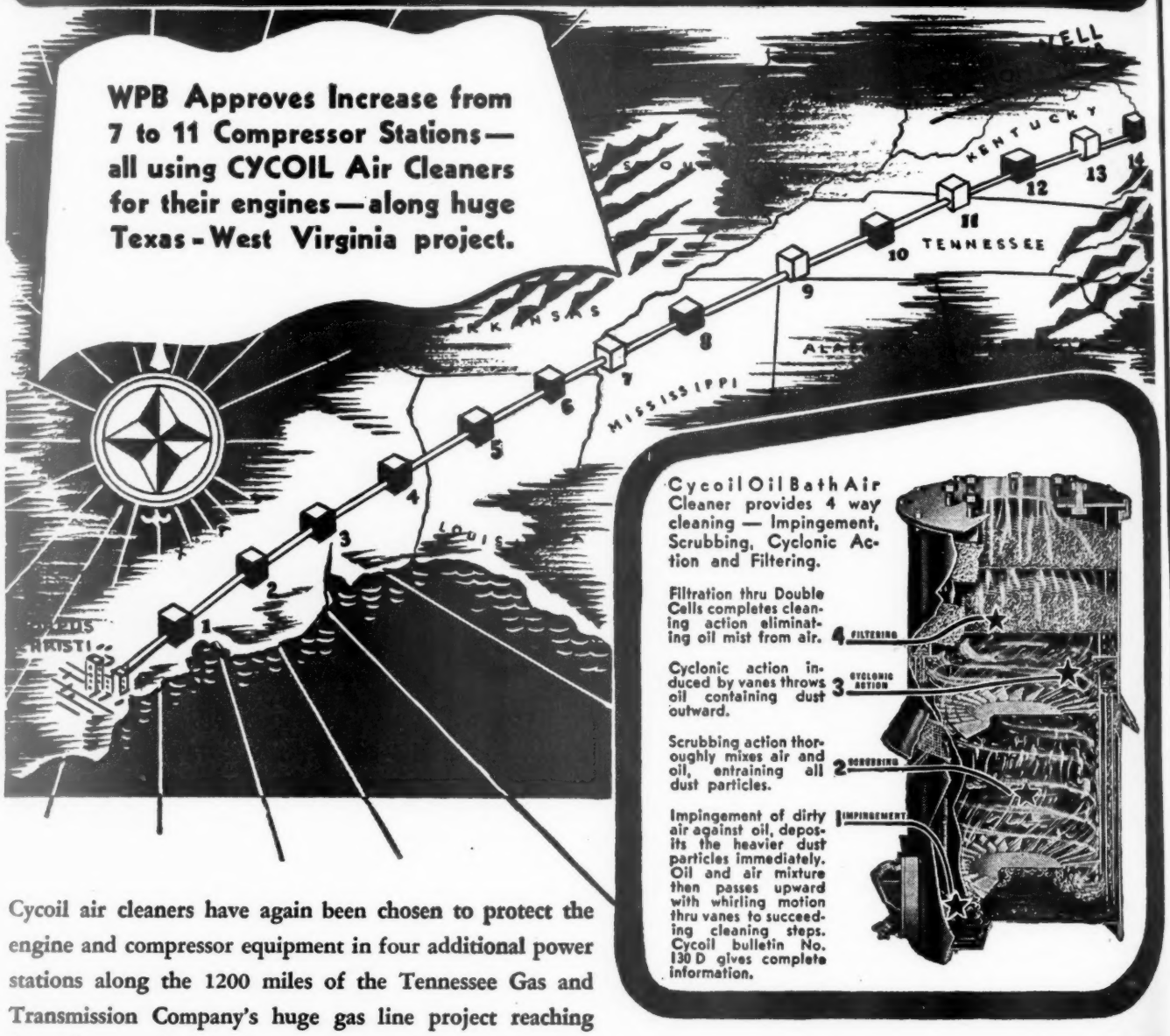
# *Cycoils* FOLLOW THE GROWTH OF THE GREAT CIRCLE PIPE LINE





Cycoil Oil Bath Air Cleaner provides 4 way cleaning — Impingement, Scrubbing, Cyclonic Action and Filtering.
Filtration thru Double Cells completes cleaning action eliminating oil mist from air.
4 FILTERING
Cyclonic action induced by vanes throws oil containing dust outward.
3 CYCLONIC ACTION
Scrubbing action thoroughly mixes air and oil, entraining all dust particles.
2 SCRUBBING
Impingement of dirty air against oil, deposits the heavier dust particles immediately. Oil and air mixture then passes upward with whirling motion thru vanes to succeeding cleaning steps. Cycoil bulletin No. 130 D gives complete information.
1 IMPINGEMENT

Cycoil air cleaners have again been chosen to protect the engine and compressor equipment in four additional power stations along the 1200 miles of the Tennessee Gas and Transmission Company's huge gas line project reaching from Corpus Christi, Tex., to Cornwell Station, W. Va. The seven initial compressor stations were Cycoil equipped when the pipe line was ready for use late last year. The additional stations recently authorized by the WPB raises the total to eleven leaving three yet to be installed. With a record of performance unequaled by any other type of engine and compressor filter, Cycoils were selected because of their high efficiency in dust removal, made possible by their exclusive 4-way air cleaning principle described above.

The Cycoil oil bath air cleaner is one of a complete line of air cleaners designed by AAF engineers for every engine and compressor service. Each filter in this line is available in a complete range of capacities. Write for descriptive bulletins.

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# INSTRUMENT DETERMINES WALL THICKNESS— LIQUID LEVEL— DENSITIES—

By **JOHN H. KUNKEL,** *Refinery Editor*

**EXCLUSIVE** By Causing beamed gamma rays to penetrate a solid, picking up and measuring the intensity of the reflected, or, more properly, the back-scattered radiation, amplifying and integrating it to produce direct current which is measured by means of a microammeter, a new portable instrument, named the Penetron, accurately and quickly:

*(a) Determines the thickness of any solid material without damage thereto,*

*(b) Externally locates the liquid level in a closed vessel without access to the interior thereof,*

*(c) Similarly makes it possible to determine the density of liquids in a closed containing vessel, and,*

*(d) Locates the interface between two immiscible liquids in a closed containing vessel.*

This new electronic instrument has been perfected by The Texas Company, and it is now being manufactured and sold under license granted to Engineering Laboratories, Inc., Tulsa, Oklahoma.

While industry-at-large will find many applications for the Penetron, the instrument is of particular interest to men in the oil producing, pipe line, refining and natural gasoline divisions of the petroleum industry because it speeds up, simplifies and results in greater accuracy when obtaining the wall thickness of pipe, heater tubes, fractionating columns, drums, tanks, etc., as well as providing other inspection data previously enumerated.

Before the development of the Penetron, several methods for determining wall thickness were employed by inspection men. These were:

(a) By drilling a hole through the wall and then calipering to measure the thickness. To restore the vessel to service, the hole was tapped, a screw-plug inserted and welded into place. This method not only was cumbersome and time consuming, but, in the case of high alloyed steels, it resulted in developing a weak spot since the welded plug usually was weaker than the original metal structure. In many instances, inaccessibility made it impossible to obtain data by calipering.

(b) In determining the thickness of a heater tube wall, the O.D. and I.D. were measured, and the average wall thickness was determined by arithmetic, i.e., the two values were divided by 2. This, by no means, was a true measure of wall thickness since the inside of the tubing may be off-center with respect to the outside of the tube, and the actual wall thickness of diametrically opposite sides may differ to a considerable degree. It often was found that, although the average wall thickness, thus established, was shown as above the allowable minimum, the actual wall thickness of one side of the tubing was well below the minimum value, and a danger point thus was present.

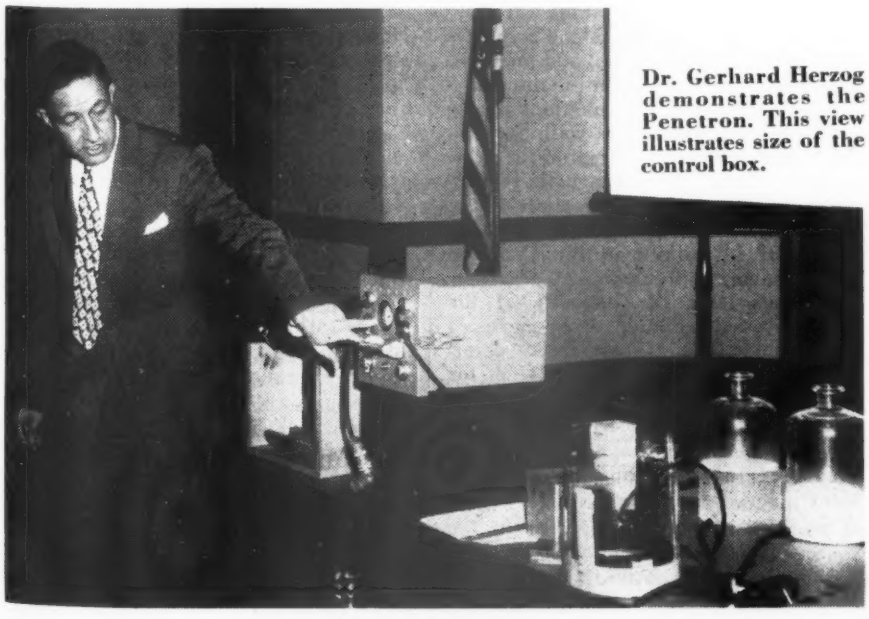
Up to the present time, determination of liquid density, or the determination of the location of the liquid level has usually involved cutting into the wall of the containing vessel, either for the purpose of installing mechanical floats, or density measuring equipment. Difficulties are sometimes encountered with such equipment in obtaining liquid tight connections, particularly where moving parts must extend through the wall of the vessel. This is especially true when the vessel contains highly corrosive liquids, or reagents, and where the work involved in making the installation appears to accelerate the corrosive action of these materials.

The Penetron is ideally suited to the determination of liquid levels, the interface between immiscible liquids, or the determination of density, since, for its operation, it does not require access to the containing vessel.

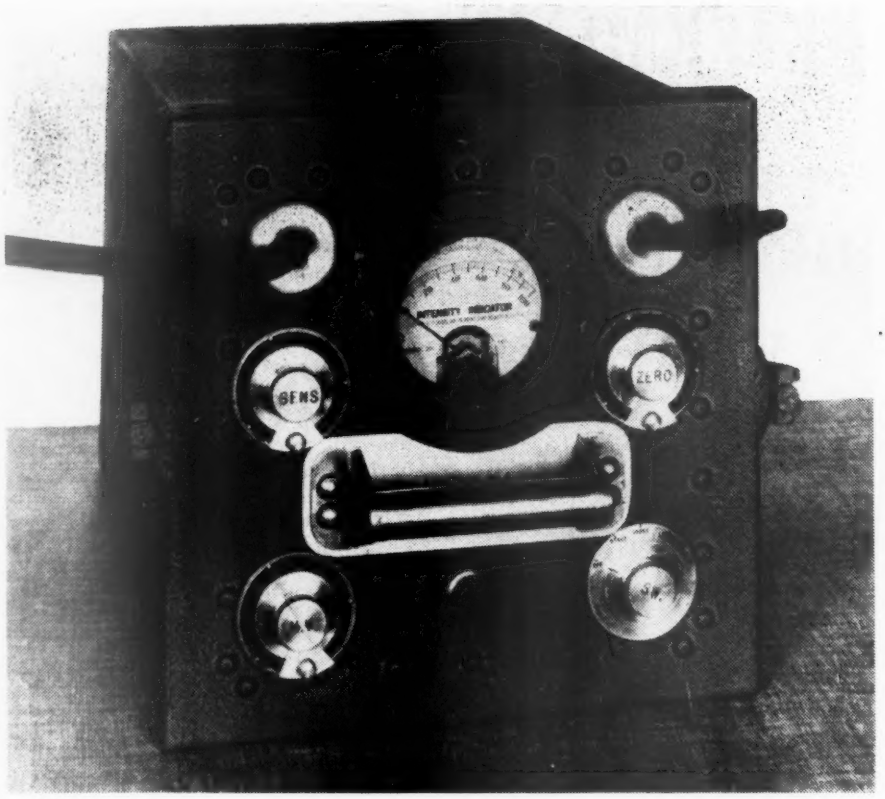
● **Background of the Penetron.** The problem of enabling inspection men to obtain data at all points accurately and quickly interested Texaco research men, and work in the direction of obtaining these results was launched a number of years ago. This work resulted in the development of the original Penetron by D. C. G. Hare, a physicist of the corporation, and in 1939 patents were applied for.

While the original equipment performed its functions adequately, it weighed 400 lb. and was mounted on a trailer. Intensive research and development resulted in a stepwise reduction in weight. The present instrument weighs only 25 lb. and is so constructed that it can easily be carried by one man.

The instrument consists of a control box housing the electronic equipment, and on the face of which is mounted the microammeter, from which readings are obtained, a flexible rubber covered cable that extends to the head, of which two are available, i.e., the conventional head, supplied as standard equipment, which weighs approximately 7 lb., or the newly developed tangential head, supplied as extra equipment, and which weighs approximately one-half as much as the conventional head. Wall thickness, liquid level, liquid density or interface is obtained simply by placing the head against the wall. The head transmits the amplified, integrated current through the cable to the control box. One man, in certain cases, can obtain the readings, but usually two operators are assigned. Only a short training period is required to familiarize operators with the procedure to be followed when obtaining readings. The instrument is designed to operate on 110 volt, 60 cycle alternating current. By means of a suitable power supply circuit, the line voltage is transformed and rectified, as necessary, for operation of the electronic circuits. Total power consumption is approximately 100 watts. For use with direct current an adapter is available. Indicative of the work output of the



**Dr. Gerhard Herzog demonstrates the Penetron. This view illustrates size of the control box.**




**The Penetron control box.**

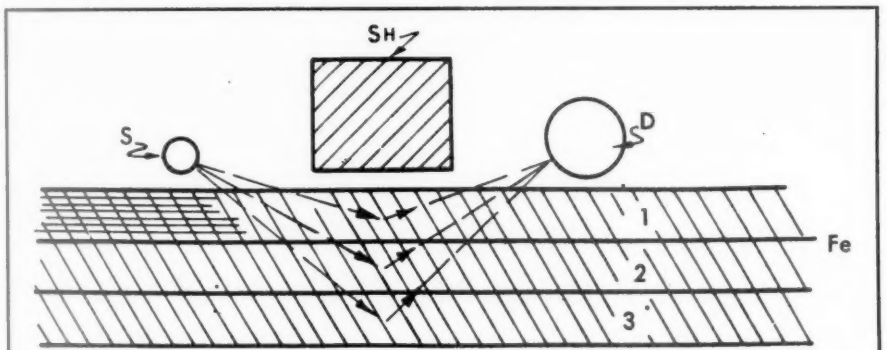



**FIG. 1. Diagrammatic Illustration of the principle involved in operation of The Texas Company Penetron.**

Penetron is the fact that measurements at 150 or more points may be taken during a regulation working day.

● **Radiation source and protection.** The source of gamma rays employed in the Penetron is a needle containing one milligram of radium in the form of commercially available salt. The source is shielded so that the beam of gamma rays is thrown in the desired direction. The thickness and design of the shield were determined after a careful study of the allowable dosages of gamma rays to which the average individual may be exposed without any physiological effects.

● **Principle of operation.** Fig. 1 diagrammatically illustrates the simple principle involved in the operation of the Penetron. The shaded layers 1, 2, and 3 represent the adjacent layers of the homogeneous wall, the thickness of which is to be measured. Penetrating gamma rays emerge from the radioactive source S. These rays impinge on the wall and penetrate into it. A portion of the rays pass through the wall and emerge on the opposite side. These rays serve no useful purpose and are disregarded. Another portion of the radiation is scattered in all directions by the atoms which make up the wall. Some of these scattered rays emerge on the same side of the wall from which they originally entered. It is this portion of the radiation, termed back-scattered radiation, that is utilized in the Penetron for measuring wall thickness.

By measuring the intensity of the back-scattered radiation, as by means of the counter D, it is possible to determine the thickness of the wall, since for a wall of any given composition, the intensity of the back-scattered radiation increases as a direct function of the wall thickness. In order that this measurement may be made with a high degree of accuracy, it is necessary to set up the source of radiation, the wall and the counter in accordance with a predetermined geometric arrangement. It should be noted that the block SH, shown in the drawing, is employed as a shield to prevent radiation from the radioactive source falling directly on the counter D.

The radiation picked up by the counter D creates current discharges, which are amplified and integrated to produce a direct current. The amount of current produced is measured by means of an indicating microammeter. The readings obtained on the microammeter, therefore, are directly indicative of the wall thickness.

● **Determination of wall thickness.** In order to convert the reading of the microammeter into wall thickness in inches, the instrument is calibrated on specimens of tubing and flat plates having known wall thicknesses, and from these data, calibration curves are derived. Because the geometrical relationship between the measuring head and the wall changes with the curvature of the wall, it is to be expected that the calibration curves for a wall of given composition will vary depending on the diameter or curvature of the wall or vessel being measured, and on whether the measurements of curved surfaces are made from the outside or inside. Typical calibration curves for measurements on iron plate, and outside measurements on iron tubing are shown in Fig. 2. Corresponding calibration curves for inside measurements on iron tubing are shown in Fig. 3.

These curves have to be established only once and are supplied with the instrument. The curves are not affected by small changes in the chemical composition of the material comprising the wall. For example, the calibration curves shown in Figs. 3 and 4 for iron also apply to alloyed steels. If, however, other materials like aluminum, brass, wood, ceramics, plastics, etc., are to be measured, different calibration curves must be employed. Typical calibration curves for flat plates of aluminum, wood, bakelite, iron, and lead are shown in Fig. 4.

Wall thickness measurements can be made on pipes or vessels that contain fluids, provided a correction is made to take into account the influence of the fluid on the reading of the instrument. The magnitude of this correction is dependent upon the density of the fluid, but for practical purposes the necessary correction can be made simply by establishing a calibration curve for pipes of known wall thickness filled with the same fluid.

An example of the type of information which can be obtained by means of the Penetron is illustrated in Fig. 5. This figure shows actual measurements made with the Penetron on a large surge drum. Contours are drawn through points of equal wall thickness.

● **Routine calibration.** With any electronic equipment failures of tubes, condensers, etc., have to be expected. In order to detect such failures a simple means is provided whereby the overall performance of the instrument can be easily and rapidly checked. For this purpose, a set of concentric half-round steel shells (Fig. 6) and a calibration curve

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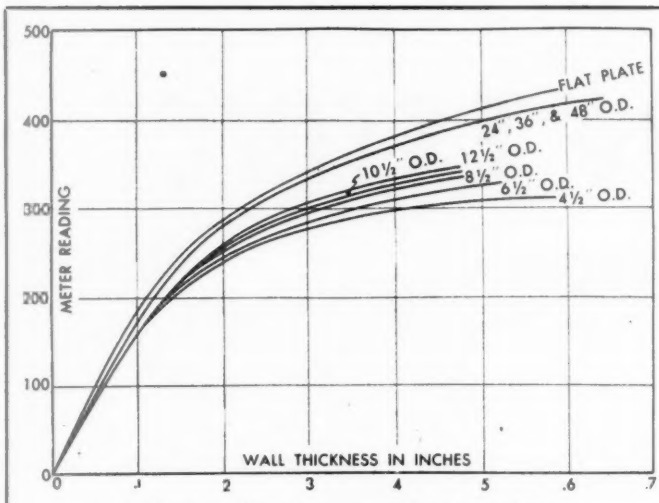


**FIG. 2. Calibration curves for iron plate and tubing — outside measurement.**

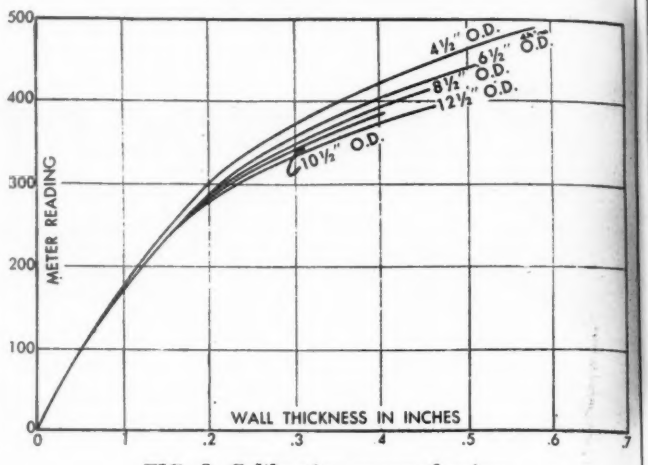


**FIG. 3. Calibration curves for iron tubing — inside measurement.**

for the standard shells are supplied with the instrument. By measuring the thickness of the standard shells, the operation of the instrument may be checked quickly at any time. Equipment failures of any type will be reflected by a deviation from the standard calibration curve.

● **Limitation and accuracy.** Referring to Figs. 2, 3, and 4, it will be seen that the calibration curves for the instrument have a rather steep slope for the lesser wall thicknesses, but tend to flatten out with increasing wall thickness. From these curves, it will be seen that the Penetron can be used for measuring iron or steel walls up to approximately 0.75 in. thickness. For other materials the limit is different as, for example, the limit of aluminum is approximately 1.0 in. This limitation is due to the fact that the penetrative power of deflected or scattered gamma rays is less than that of primary rays, and rays that are deflected beyond a certain depth are completely absorbed before reaching the surface as back-scattered radiation.

The accuracy of the instrument has been established by conducting hundreds of experiments with specimens of unknown wall thickness. After determining the thickness by means of the Penetron, the specimens were drilled and calipered mechanically. By this method, using the conventional head, the Penetron has been shown to have an accuracy within plus or minus 3 per cent.

● **Time required for making measurements.** The individual pulses of current created in the counter do not follow each other at regular intervals. In fact the rate of emission of gamma rays by radium is quite irregular. It follows certain statistical laws, and fluctuates around an average value. The accuracy with which this average value can be determined experimentally increases as the time of observation is increased. Considerations of this led to the establishment of a minimum time for any measurement in radioactivity in order to achieve the required accuracy. In the case of the Penetron, the minimum time for accurate reading, plus or minus 3 per cent, is 25 seconds.

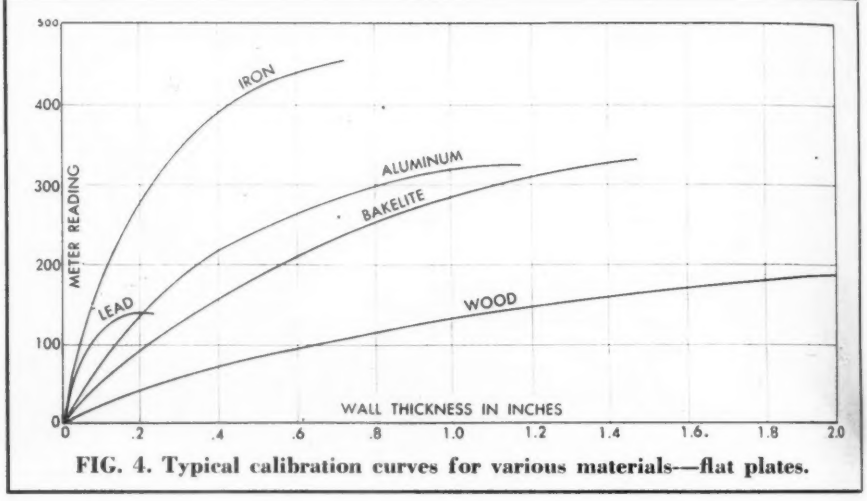


**FIG. 4. Typical calibration curves for various materials—flat plates.**

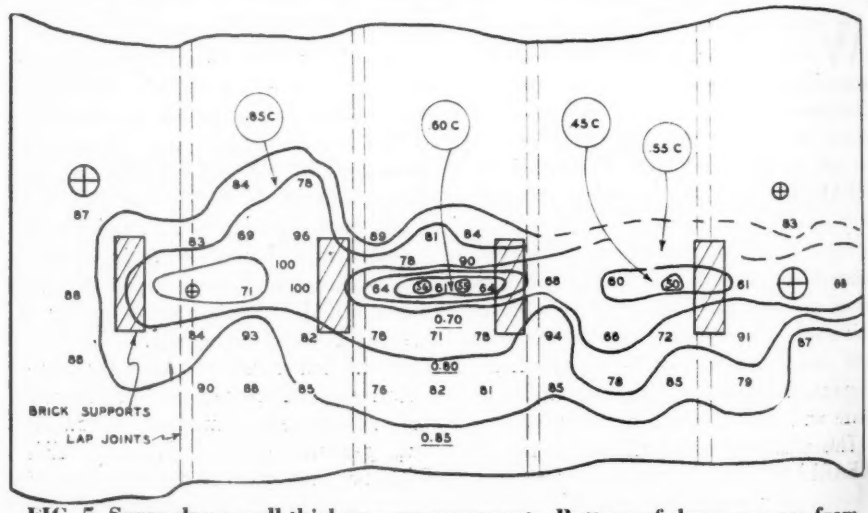


**FIG. 5. Surge drum wall thickness measurements. Bottom of drum as seen from the inside (measurements made from outside). Figures show measured wall thickness in hundredths of an inch.**

● **Determination of liquid level.** The Penetron accomplishes its various functions by accurately measuring the amount of back-scattered radiation. If the head of the Penetron is placed on the wall of a vessel partially filled with liquid and above the level of the liquid, the amount of back-scattered radiation will be due entirely to the wall of the vessel, since the density of the air or vapor in the vessel is substantially negligible by comparison with the density of the material comprising the wall. If the head is moved down along the wall of the vessel the reading of the instrument will remain constant until it reaches a point opposite the level of the liquid in the container. At this point the meter

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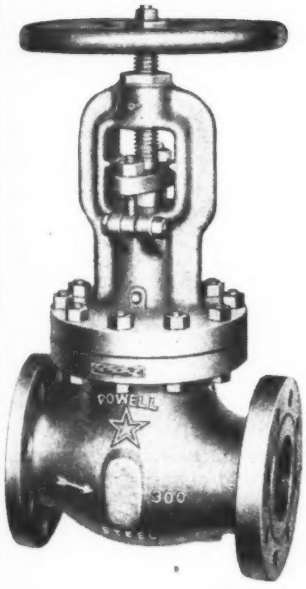


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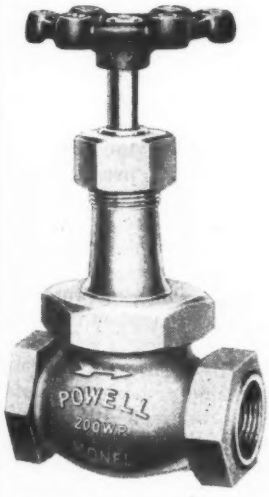


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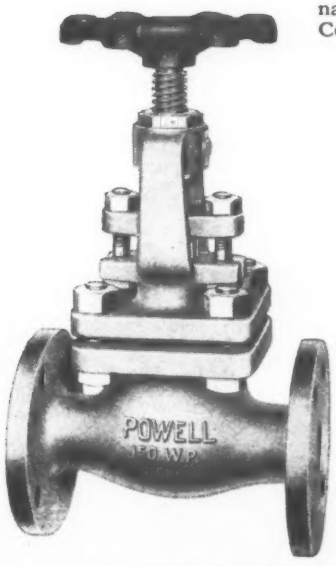


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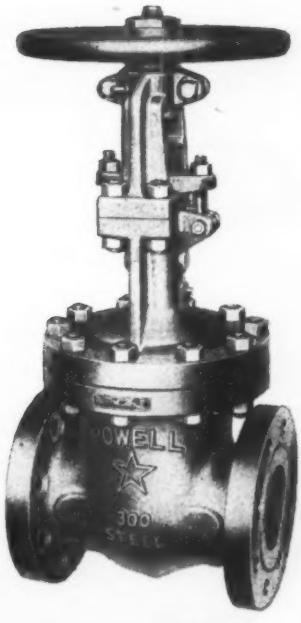



Class 300-pound Cast Steel Globe Valve with Monel Metal trim.

# POWELL VALVES

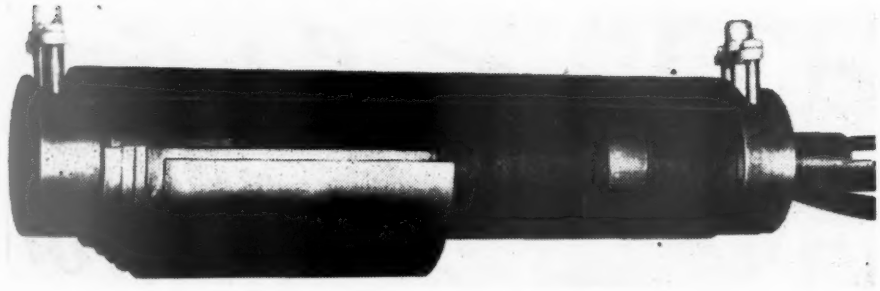


FIG. 6. Concentric steel shells for calibration.

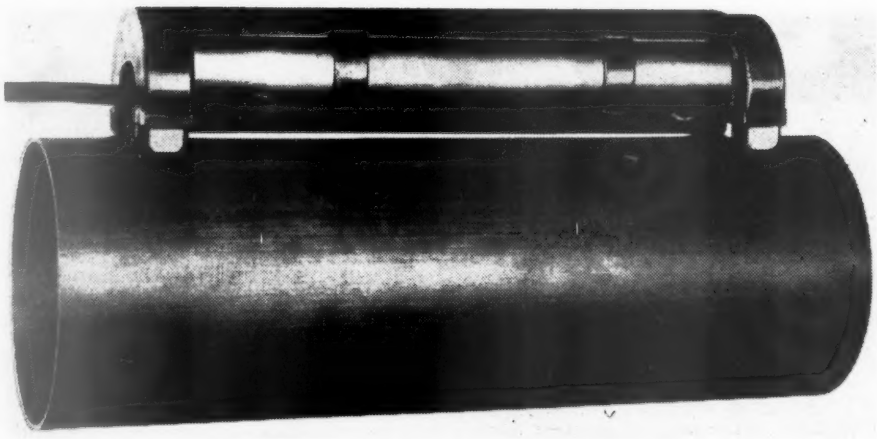


FIG. 7. Head in position in magnet type holder.

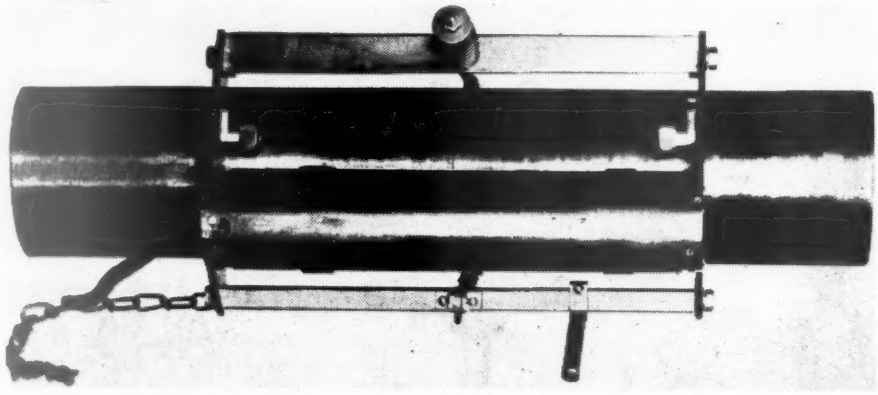
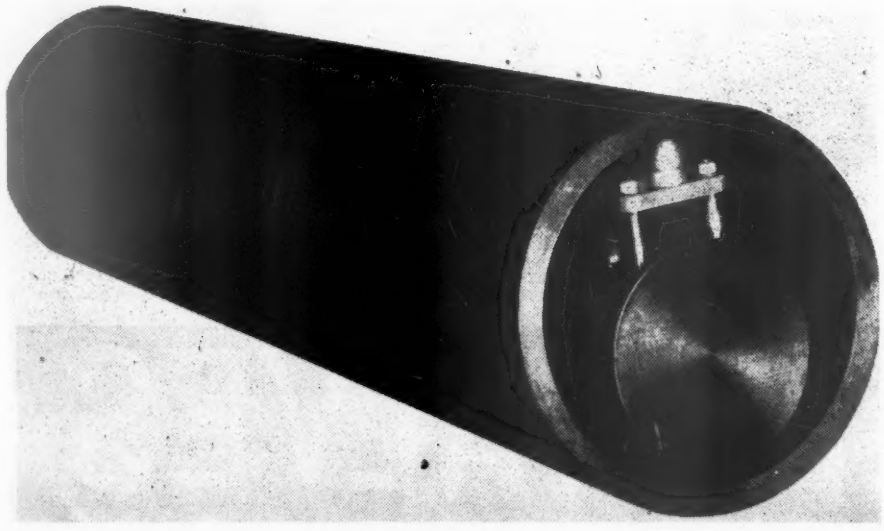


FIG. 8. Head in position in clamping chain type holder.

FIG. 9. Head in position in pneumatic type holder for I.D. measurements.



of the instrument will indicate an increase in the amount of back-scattered radiation, due to the fact that the radiation passing through the wall is scattered not only by the wall but also by the liquid in the vessel. By noting the point on the wall of the vessel at which an increase in the reading of the instrument is obtained, it is possible to locate the level of the liquid quite accurately. Likewise, the interface between two fluids of different densities can be located easily and accurately from the outside of a container without actual access to the interior of the container.

By proper instrumentation the Penetron may be adapted to control as well as to locate liquid levels. In addition, a continous record of the location of the levels may be obtained by employing a recording device. The following are a few specific examples of some of the types of liquid level measurements that may be made with the Penetron:

**Gaging liquids in storage tanks.**

**Gaging liquefied gases in cylinders.**

**Controlling levels in process units, such as the solvent-oil interface in a solvent refining tower.**

**Determining and controlling the catalyst level in catalyzed chemical reactions.**

These constitute only a few of the many possible applications.

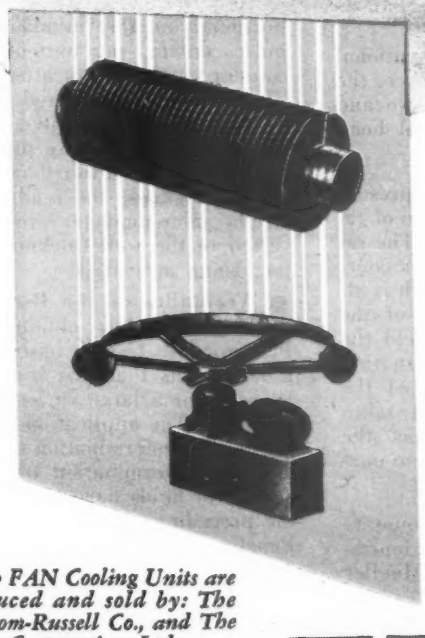
● **Determination of specific gravity of fluids.** All penetrating radiation is to a certain extent scattered or diffusely reflected by the material it traverses, and the degree of scattering is a function of the number of electrons encountered by the penetrating rays in their passage through the material. Since the total number of electrons present in a unit volume of any substance is closely related to the density of that substance, it is apparent that the amount of scattering per unit volume is largely dependent upon the density of the material. Therefore, as the density of the material increases, the amount of back-scattered radiation measured by the Penetron, also increases, and for practical purposes the Penetron measures density. For this reason, the density of a fluid inside a container may be determined directly without actual access to the fluid itself. In actual experimental work employing a Penetron situated on the outer wall of a container having a wall thickness of 0.3 in., it was found possible to check the specific gravities of fluids having values of between 10° Baumé and 75° Baumé with a high degree of accuracy, values obtained by the Penetron checking very closely with gravities obtained on the fluids by conventional methods.

The following are given as a few typical examples of measurements that may be made based on the determination of the specific gravity:

**Specific gravity of liquids in tankage.**

**Routing the flow of oil in pipe lines.**

**Control of blending operations.**



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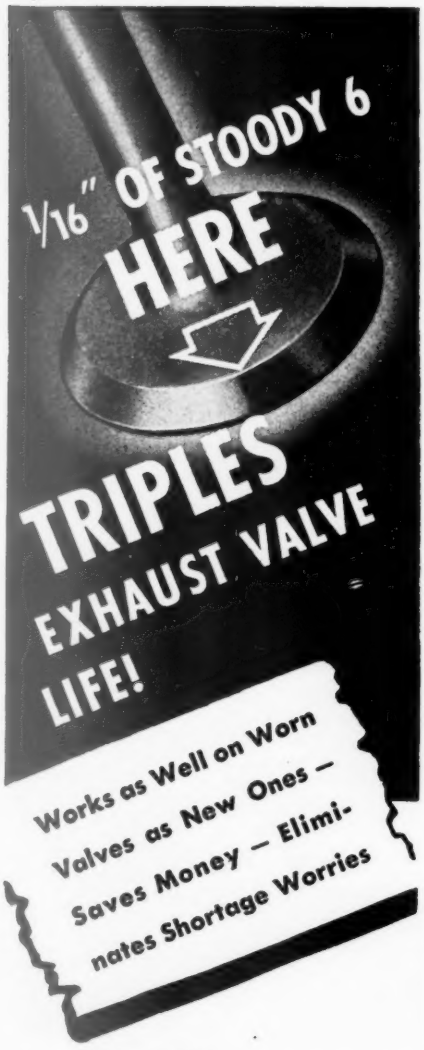
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**in which two materials of different densities are mixed.**

**Determination and control of proportions of reactants in chemical processes.**

In addition, numerous other applications are possible, particularly wherever it is desired to determine the density of a substance without the necessity of sampling or without actual access to the material.

● **Description of the individual parts.** The Penetron consists of two main parts; namely, the head and the control box. The head contains the radiation source, the counter, a shield between the two and a preamplifier. It is connected by a cable of 75-ft. length to the control box which contains the measuring circuit and the power supply.

● **The conventional head.** The conventional head consists of steel tubing 2½ in. in diam. and 13 in. long. It can be inserted in various holders. One holder (Fig. 7) is equipped with two permanent magnets, that serve as supporting points for the head and at the same time serve to hold the head firmly in position on iron or steel surfaces. Another holder (Fig. 8) is provided with a chain clamping device for use on nonmagnetic materials. If measurements are to be taken on the inside of tubings, the pneumatic type holder of Fig. 9 is used. It is equipped with two pistons that can be moved by compressed air or fluid pressure. These pistons press the head against the inside of a pipe or tube in any desired direction. The clamp is maneuvered with extension handles, and measurements can be made at any desired point along the inside of tubes of any length.

As mentioned before, the conventional head contains the radiation source, the counter, a shield between the two and a preamplifier. The conventional head weighs approximately 7 pounds.

● **The radiation source.** The present instrument employs one milligram of radium as the gamma ray source. The radium is supported at the apex of a cone-shaped element, the base of which is attached directly to the housing of the counter. This cone serves to shield the counter from direct radiation emanating from the radium. The lifetime of the radium source is unlimited. It takes more than 16 centuries to reduce the quantity of gamma ray emission to one-half its original value.

● **The counter.** Two kinds of counters for gamma rays are known—the ionization chamber and the Geiger-Mueller type of counter.

In the Penetron, a gamma ray counter is contained in a housing that is fitted longitudinally into the head and shielded in such a way that it is open to radiation coming from one side only. The open, or unshielded, side faces the wall to be measured. Back-scattered radiation from the wall being measured enters the counter through the unshielded area and sets off current discharges or pulses in the counter. The rate at which these pulses of current are generated is proportional to the intensity of the radiation entering the counter, which, in turn, is a function of the wall thickness.

● **The preamplifier.** The pulses of current produced in the detector are extremely small. Since these pulses must be transmitted through 75 ft. of cable it is necessary that they be increased in magnitude sufficiently to be distinct when they are picked up at the measuring circuit in the control box. This function is performed by the preamplifier situated in the head of the instrument.

● **Tangential head.** The newly developed tangential head, available as extra equipment, has several advantages not found in the conventional head. It requires considerably less working space than is required by the conventional head, and it is lighter in weight than the conventional head. The tangential head differs from the conventional head in that it employs the tangential transmission of gamma rays and has an accuracy of plus or minus one-hundredth of an inch.

● **The control box.** As stated previously, the control box contains the measuring circuit and the power supply. The control box is constructed of lightweight sheet iron. It is 9½ in. long by 9 in. wide by 14 in. in depth. The control box, including all equipment contained therein, weighs approximately 25 lb.

● **The electrical circuit.** Amplified pulses of current are transmitted from the head through the 75-ft. cable to the control box. Here they are further amplified and by means of a special electrical circuit are integrated to produce a direct current, the magnitude of which is proportional to the number of current pulses created per unit of time in the counter by the back-scattered radiation. The current is measured by means of a microammeter situated on the face of the control box. By proper calibration against standard specimens of known thickness the readings obtained on the microammeter are readily converted to the wall thickness of the object being measured.

● **Versatility of the Penetron.** Since the measurements obtained with the Penetron are largely based on density, it is obvious that this instrument may be used for a large variety of different purposes. The applications of the Penetron to the determination of liquid level and the determination of the specific gravity of fluids have been discussed in the preceding sections. In addition, the Penetron may be used for controlling operations involving certain chemical reactions. It also has numerous other uses that are being given consideration.

● **Acknowledgments.** The writer is indebted to Texaco Development Corporation for permission to quote extensively from its literature on this subject, to Robert C. Granner of Engineering Laboratories, Inc., for the courtesy of a demonstration of the Penetron, to Dr. Gerhard Herzog of The Texas Company, and to C. F. Teichmann of The Texas Company for courtesies extended. ★★★

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# *Conservation of the Nation's* NATURAL GAS RESERVES

By **ALEC M. CROWELL***

**EXCLUSIVE** THE evolution of engineering principles in natural gas conservation during the great strides that have been made in conservation practice over the past years was to have been the topic of this article. In the beginning, however, it became evident that the legal and economic aspects outweigh engineering considerations—but the fact remains that the ever-improving conservation of natural gas reserves and the efficient production, transmission, and utilization of natural gas is a direct result of applied technology.

Alec M. Crowell

Certain principles governing the wise exploitation of natural gas reserves have been agreed upon by technologists through cooperation with each other in the acquisition and exchange of factual data and in the acceptance and promotion of proved good practice. As a practical matter, this exchange of experience follows very closely the Interstate Oil Compact Commission's pattern of operation.

Fortunately, the principal supply of natural gas for the United States is confined to states that are members of the Interstate Oil Compact Commission. This means that approximately 90 per cent of the nation's natural gas reserve is represented in the open forum of the state conservation bodies.

Ten years ago it was estimated that the reserve-demand ratio of natural gas was 30 years. Since that time the volume of natural gas marketed has practically doubled, products recovered at gasoline and cycle plants increased more than 1½ times, carbon black production has more than doubled, and the reserve-demand ratio has risen to 31 years. From the end of 1935 to the present it is estimated that with an increase of only 10 per cent in the number of producing gas wells recoverable reserves have increased from 62 trillion to 156 trillion cu. ft. There was a lot of good conservation between.

For the sake of brevity, and to limit the discussion to one of at least partial personal knowledge, the observations made here apply principally to the states of Louisiana, Arkansas, Texas, Oklahoma, and Kansas. This group of five states is credited with 82 per cent of the reserves of natural gas of the nation. Here, in these states, by actual practice, has been demonstrated the desirability of gas conservation from the economic, legal, and engineering viewpoints.

● **Types of gas reserves.** These southwestern states are producers, and state officials view the natural gas industry through the producers' eyes. Natural gas reserves in these states are of three types: (1) Oil well or casinghead gas, (2) gas well or dry gas, and (3) gas from the rapidly growing number of deep, high pressure, "gas-condensate" reservoirs. The three type reserves mentioned present a myriad of problems, but to these problems must be added those of oil conservation. This for the reason that the inherent nature of petroleum reservoirs directly interrelates gas conservation and oil conservation. They go hand in hand and no proper application of waste prevention practices can be made separately. The two must be treated simultaneously.

● **The problem of conservation.** Numerous gas wells produce both gas and oil and practically all oil wells produce both oil and gas; also in numerous reservoirs the gas is either itself the source of the oil or condensate production or expansion of the gas in solution in the oil is the energy by which the oil is produced. In all such cases waste of gas reduces the ultimate quantity of recoverable petroleum. Further, it can be said that 75 per cent of the recoverable oil produced today is lifted from reservoirs by natural gas before any assistance is given by water drive. Therefore, gas conservation in the production of oil is basic.

Now to make the problem complex, not only do the Mid-Continent and Gulf Coastal states depend upon the southwestern gas reserve for fuel, light, and heat, but pipe line companies transport gas to the industrial centers of the Appalachian and North Central States. Unlike oil, gas transmission lines are not common purchasers. Gas fields are prorated so that the market demand from each field will be produced ratably. In most instances, a gas transmission line cannot be forced to enter a gas field, but if it does enter a field, it can be forced to take gas ratably in order to supply its needs. We know of no authority for saying that a gas line can be compelled to take casinghead gas from the wells or to take residue gas from the tail gate of a processing plant. We see, therefore, that the conservation of casinghead gas is primarily the problem of the oil producer.

A point of contention, the price paid to the producer by the gas pipe line company, in most instances, is the result of a series of governmental controlled prices. The price of gas to the consumer is controlled by the state utility commission's control of the utility company's earnings and the earnings of the transporting pipe line company is limited by the same commission for intrastate lines and by the Federal Power Commission for interstate lines. The price to the consumer must of necessity be competitive with other fuels.

As a rule the oil producer is not interested in problems that may exist in fields that produce gas alone, and there is no particular interest for the gas pipe line company in fields that produce oil as a result of water drive with very little gas. Conceding this to be true, the major problems of conservation for both the oil and gas producer and gas pipe line company undoubtedly arise in combination fields that produce both oil and gas.

The solution is not so simple as the problem reads. Gas to be delivered into a pipe line must meet certain specifications. It must be free from sulphur, foreign materials, and condensates. If delivered at high pressure, it must be dehydrated so that the moisture in the gas will not freeze the lines. If delivered at low pressure, it must be compressed to line pressure. The expenditure that can be made by a gas company to gather this gas depends upon the amount of reserves that may be recovered and the cost. Also, much depends on the cooperation between the operators of the gas lines and the producers of gas from oil wells.

The quantity of gas produced with the oil from an oil well is usually dependent upon a fixed oil allowable. Gas pipe lines cannot take and absorb at all hours of the day at the rate of the flow of oil production. Gas demands fluctuate during 24 hours in the day and during various months in the year. Gas pipe lines have no storage except that which can be stored in the pipe line itself and the few underground storage projects; therefore, they must depend upon receiving their supply from wells to which they are connected at the same

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rate of flow that they deliver their gas to their markets.

Oil, on the other hand, may flow on a regular basis, usually the same quantity every hour of the day, because it may be stored and the fluctuation of the market demand for oil to the ultimate consumer is handled from storage tanks, which have no relation to production from the wells.

Experience is proving that oil well gas can be taken by pipe lines when the operating problems mentioned can be solved and there is sufficient reserve to warrant the cost of connection. Not all oil well gas can fit economically into a pipe line operation. This is not a problem of the gas pipe lines companies alone, as in the end they are not producing this gas and cannot be called upon to make uneconomical expenditures to handle gas that is being produced with oil.

● **Gas for carbon black manufacture.** Carbon black offers another useful disposition of gas — a usefulness that has been accentuated by the war. Early in its history, the carbon black industry paid for its raw material on the basis of a fixed percentage of plant revenue. This practice has been continued through the years and has given no incentive to sale of gas for carbon black. Producers were satisfied so long as carbon black prices were high enough to yield a reasonable gas price, however, competitive carbon black prices have lowered the price paid for gas used in channel-type plants before the war to about 1½ cents per 1000 cu. ft. in many areas.

Prior to the war, carbon black manufacturers endeavored to locate plants in fields where the available gas supply would permit a long term pay-out. As a result, plants were located in fields that had large reserves and were also used to supply gas pipe line companies. With the increasing pipe line demand for gas, however, it is becoming more difficult for carbon black manufacturers to obtain their gas supply in these fields due to the fact that pipe line companies are willing to pay and can support higher field prices.

Also with the increasing demand for gas, there is a tendency on the part of producers to save in the ground both sweet and sour gas for ultimate pipe line use. Therefore, carbon black companies are being forced to seek supplies of distress gas, which will only allow a comparatively short term pay-out. These supply sources, then, are limited almost entirely to low pressure casinghead or residue gas from gasoline plants that cannot economically be connected to pipe line systems.

● **Reserves in gas-condensate fields.** The growing number and increasing reserves of natural gas in deep high pressure gas-condensate fields certainly presents a problem that must be added to those mentioned. These reserves exhibit a complex phenomenon of retrograde behavior. This for the reason that any appreciable pressure drop in reservoirs of this type will result in condensation of heavy hydrocarbons, and the problem of conservation becomes twofold—that is, to provide maximum ultimate recovery of both the light and heavy hydrocarbons. Recent tests by the U. S. Bureau of Mines on several large and well-known condensate fields show that actual reservoir pressures are only from 100 to 150 lb. per sq. in. higher than the dew point of the reservoir gases. In actual operation, we are dealing with a narrow increment of pressure and have only a small safety factor to prevent a reduction in reservoir pressure such as would cause an irrecoverable loss of liquid hydrocarbons through condensation within the reservoir.

Going from problem to practice, there has been an accelerating trend of improvement in natural gas conservation and in efficient production, transmission, and utilization of natural gas during the last few years. Perhaps more progress has been made in the last 15 years than during the rest of the 170 years of natural gas history in the United States.

A cooperative study made by some 250 operators, executives, and engineers can mark the point when science became the principal means of yield from petroleum reservoirs. The findings of the group were made easily understandable in "Function of Natural Gas in the Production of Oil" published jointly by the API and Bureau of Mines in 1929. Here, by intelligent analysis of factual experience, began to be fixed good and bad operational practice.

● **Historical background.** True, the store of practical knowledge had been added to slowly since natural gas was discovered in 1775 in West Virginia, partly through thousands of wells that were drilled and the exploitation and utilization of the natural gas reserves discovered, alone or with oil, in West Virginia, Pennsylvania, New York, Ohio, Indiana, and Illinois.

The reserves of natural gas in the area were contained in many comparatively small low pressure fields near the market. These fields provided an uncertain supply, for methods of determining reserves had not been developed, proper conservation was unknown, long distance transmission had not been developed, and financing was difficult. By 1920 the cream had been skimmed from these reserves but industrial machinery had developed an ever-increasing demand for natural gas.

Fortunately, during the 20's the tremendous reserves of the Southwest began to appear. There was Monroe and Richland of Louisiana, the Panhandle of Texas, and Hugoton of Kansas. Although not so spectacular, reserves were being built up in hundreds of fields from Mississippi on the east to New Mexico on the west.

To bridge the gap between the markets developed in the industrial eastern states and this growing supply in the Southwest, metallurgy, pipe line capacity, and capital all combined to make

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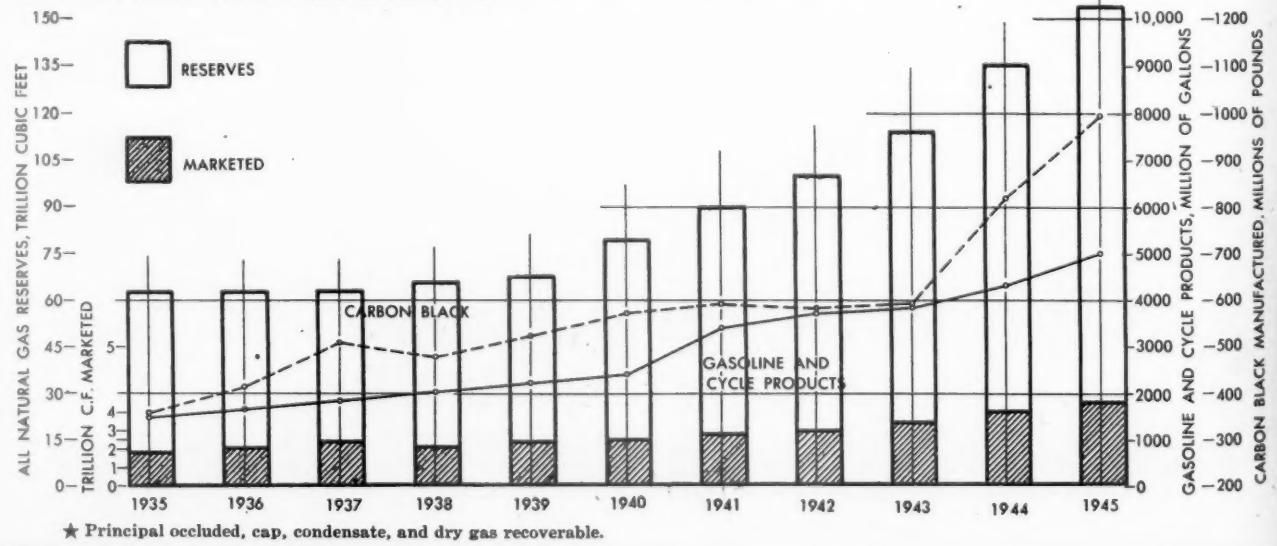


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VENTURA, CALIF.
BAKERSFIELD, CALIF.
AVENAL, CALIF.
SACRAMENTO, CALIF.

| Year | No. gas wells, thousands, Dec. 31 | Natural gas, billion cu. ft. | Natural gasoline production, million gal. | Total products natural gasoline and cycling plants | Carbon black production, million lb. | Reserves in trillion cu. ft. |
|---|---|---|---|---|---|---|
| 1935 | 54 | 1916 | 1651 | .... | 353 | 62 |
| 1936 | 55 | 2167 | 1796 | .... | 411 | 62 |
| 1937 | 55 | 2407 | 2065 | .... | 510 | 62 |
| 1938 | 54 | 2295 | 2156 | .... | 477 | 65 |
| 1939 | 54 | 2476 | 2129 | 2169 | 525 | 76 |
| 1940 | 54 | 2660 | 2173 | 2339 | 569 | 80 |
| 1941 | 56 | 2812 | 2208 | 3396 | 594 | 90 |
| 1942 | 56 | 3053 | 2071 | 3600 | 574 | 100 |
| 1943 | 57 | 3414 | 2115 | 3684 | 593 | 115 |
| 1944* | 59 | 3780 | 2188 | 4202 | 760 | 135 |
| 1945† | 60 | 5000 | 2500 | 5000 | 1000 | 156 |

*Preliminary figures.
†Estimate.

With the exception of reserve estimates, and all figures for the year 1945, this information was obtained from the U. S. Bureau of Mines.

possible the long-distance, high-pressure, large-capacity pipe lines to previously unavailable markets.

As the drill went deeper and the compact gas-condensate reserves came to light in southern Arkansas, Louisiana, and the coastal plain of Texas (about 150 of these fields now) gas cycling and still more gas pipe lines to far distant markets came into being. Some of these lines were laid hurriedly, as a war measure, and amid a great amount of both favorable and unfavorable publicity. As a result, the people of the Southwest became conscious of the fact, some of them for the first time, that natural gas has a dollar and cents value. This discovery alone may give great impetus to the conservation movement.

To get back to the slowness of development, it was not until 1911 that the orifice meter was invented, although gas had been transported through pipe lines since 1870 and natural gasoline manufactured since 1904. This explains to a large extent the absence of early statistics.

Although begun in 1911, by the use of air, it was 10 years ago before the present practice of stimulating production from petroleum reservoirs by forcing extraneous gas into them became good practice. Now, there are hundreds of gas-injection operations in the oil fields of the country.

All of us are familiar with terms that were brand new only a few years ago. We speak of the importance of utilizing reservoir energy, maintaining reservoir pressure to increase ultimate recovery of oil, managed production rates, unitization of pools as a means for increasing oil recovery, secondary recovery methods, acid treatment of wells, bottom-hole pressure and temperature, back-pressure testing of wells, water-syphons, dehydration of gas, desulphurization on a commercial scale, fluid level, drawn-down tests, deliverability potentials, pressure maintenance, reservoir equilibrium, cycling, optimum withdrawal rates, proration, etc.

Then we have straight hole drilling, mud-laden drilling fluid, wireline coring, electrical logging, and permeability, porosity, and saturation tests of cores at the well. Further, there came the practice of setting casing through the pay formation and gun-perforating and treating lime formations with acid to increase the natural porosity and permeability.

Today we accept as commonplace the data that picture the structure and pay-thickness of the reservoirs containing the natural gas reserves. Complete hydrocarbon analysis of reservoir gases and fluids, productivity tests made progressively on individual wells, and accurate data on gas, oil, and water production are correlated with subsurface pressure surveys by reservoir engineers to determine and recommend good practice.

● **Regulation has made progress.** By means of their own staffs, industry engineering committees, special study groups, and oil company research and engineering staffs, the states are collecting these factual reservoir engineering and geological data. With all the speed possible, allowing for proof of engineering recommendations, improvement is being made in field rules and basic proration orders by the states.

Waste of oil and gas in completing and equipping wells is so small that it is no longer mentioned. All states have rules and regulations that effectively prevent this form of waste.

There has been a great deal of excellent work done on gas-oil ratios in all states. It is not always an easy matter, in adopting rules and regulations, to determine just what the most efficient gas-oil ratio for an oil field should be. It is even more difficult in a great many cases to make this ratio effective after it has been determined.

The states early found that a gas-oil ratio limit, *per se*, is no panacea. It is not enough merely to promulgate a rule fixing a maximum permissable ratio; there must be some device for enforcing it. There were not, in the first place, many operators who knew within accurate limits at what ratios their wells produced until very recently.

Gas-oil ratios were measured according to three standards up until a very few years ago, all of which are only distantly related to the standards for measuring natural gas. If a well did not make enough gas to light a cook stove on the lease it was considered to have a low ratio. If, on the other hand, it was possible to hear the riser screaming for three-quarters of a mile, the well's ratio was apt to be considered inherently high. All wells falling between these two extremes were dismissed as having average ratios.

It was obvious, therefore, that before much could be done toward conservation from a gas-oil ratio standpoint, facilities and standard procedures must be developed for the actual measurement of gas volumes produced with oil.

Accordingly, orders were promulgated fixing the procedure for measuring gas volumes used in computing gas-oil ratios. Policy has been initiated requiring rotating statewide ratio surveys, which insure a test of every well at least once a year. In areas where a chronic gas-oil ratio problem exists, these surveys are made much more often. In some fields, tests are made once each month, and in others they are taken each three months, etc., according to the producing characteristics of each particular area.

● **Gas-oil ratio programs.** With this information available, effective gas-oil ratio programs have been installed.

This program has been enforced primarily by the simple expedient of setting a gas limit for each well, and reducing the well's oil allowable—if it has a ratio above that set for the field—to a point where it is allowed to produce no more gas than if its ratio were normal.

Such a device accomplishes its purpose, of course, only if the ratios that are reported are accurate, and as it is patently impossible to test all or even a majority of the thousands of oil wells, a process of spot checking has been resorted to, in determining whether conditions or inaccurate tests have resulted in the use of erroneous ratio values.

By this method, it has been possible to set up a satisfactory working program that has produced excellent results. Reducing the allowable of wells having excessive ratios has been beneficial to the reservoir from two points of consideration: (1) The formation ratio has been improved by increasing the amount of oil produced with an efficient amount of gas, and (2) the reduction in the allowable has been an inducement to the operator of the high ratio well to perform corrective work, and thus bring his well within the limitations set for the field.

In some fields, however, it is permissible to produce oil allowables of wells with high gas-oil ratios from other wells on the same lease having low ratios. The high ratio wells are tested periodically but remain closed between surveys. Similarly, credit is given the high ratio wells for any gas that is injected into the particular reservoir.

To take care of the problem of gas wells producing from the same common reservoir as oil wells, the volumetric displacement rule is in effect. Under this policy, production from a gas well is restricted to the same amount of space voided by production from an oil well. This volumetric displacement rule has resulted in reservoir equilibrium. It has been the means of preventing shrinkage of gas caps and loss of oil by up-dip migration into the dry gas portions of reservoirs.

These programs have, therefore, resulted in an increased efficiency in the production of oil, and added to the recoverable reserves of the nation. As that is the goal of all conservation measures, they have established their worth, and accomplished their purpose.

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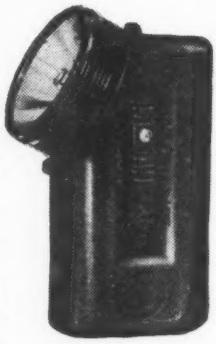

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● **Dry gas fields.** In a dry gas field, the problem is to prevent underground waste, and the present policy of uniformity of spacing and withdrawals is being continued. The benefits of proration in gas fields will be increasingly evident for the next several decades. There are fields, however, in which available gas is not provided with a market outlet due to refusal of pipe line companies to accept additional connections. This may be changed by the recent decision of the Supreme Court of the State of Texas in Corzelius vs. Harrell, original opinion rendered April 4, 1945. In that case the Texas Statute at issue provides, in Section 10, the Railroad Commission shall prorate and regulate the production of gas for the protection of public and private interests:

(a) In the prevention of waste

(b) In the adjustment of the correlative rights and opportunities of each owner of gas in a common reservoir to produce and use and sell such gas.

The Court said:

"In this case we are concerned with the production of natural gas in a gas field, and also with the question of correlative rights of the various owners of properties in the field. Subsection (a) (authorizing waste prevention) and sub-section (b) (authorizing the adjustment of correlative rights) of Section 10 are not dependent on each other. They are coordinate and each has its own independent standing in law. Unquestionably, we think, that Section 10 authorizes the Railroad Commission to prorate and regulate the daily gas production from each common reservoir in order to prevent waste and adjust correlative rights as provided in Subsections (a) and (b)."

Conservation-wise, the practices of the states holding 82 per cent of the natural gas reserves of the nation are improving. Increasing control is being exercised over high gas-oil ratio wells, more and more gas is being purchased ratably and with better prices at the wellhead, means have been discovered to free gas from sulphur and condensate, oil operators are cooperating with gas pipe lines by setting up flow schedules so that gas may be more readily available for purchase, and there is every likelihood that the manufacturer of carbon black will offer a competitive price for gas to fill his needs. The Fischer-Tropsch process for directly converting natural gas into gasoline and other liquid petroleum products may provide additional demand and impart greater value to natural gas reserves.

There are now in operation or under construction 40 cycling plants in the condensate fields of the nation, and with the increasing use of natural gas as a raw material in chemical processes together with the increasing demand for natural gas as fuel, additional emphasis has been and will naturally continue to be brought to bear on the conservation of this vital, irreplaceable natural resource. ★★★

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# Conversion Report!

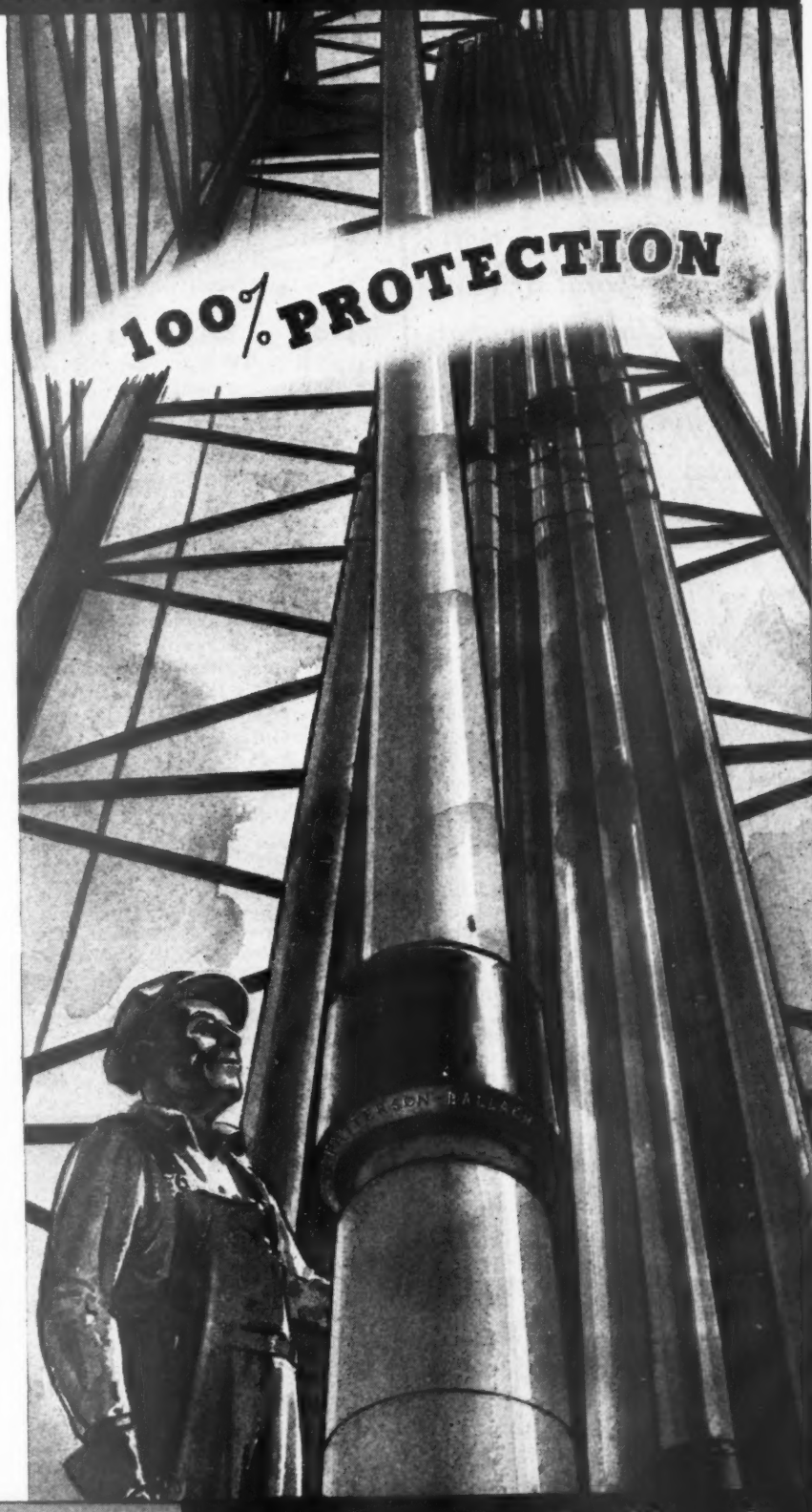
A world-wide test of PATTERSON-BALLAGH Protectors and other products involving a half million pounds of synthetic rubber, tried in thousands of wells has given an answer of satisfactory operation in two war-years that would have taken ten peacetime years. For two years PATTERSON-BALLAGH has been converted 100% to the use of PBX Synthetic Rubber, using no plantation rubber whatever. PATTERSON-BALLAGH believes PBX to be the finest compound ever developed for casing protectors and other products.

Today's increased drilling speeds introduce certain problems when drilling in large casing, just one of which is "whip." To withstand these strains, manufacturers are supplying large diameter tool joints. Even with this change, wear on tool joints is excessive. Trouble is experienced with "twist-offs" and bent or broken drill pipe.

The "critical speed" zone necessary to reach high operating speeds develops such "whip" that frequently there is not enough power available to pass through this zone. The result is that drilling cannot be done at high speed.

Operators advise that PATTERSON-BALLAGH Stabilizers are often practical in open hole, and when so used reduce sticking of drill pipe by "mudding" off walls, reducing tendency to "key seat". Torque gauge often shows friction reduction up to 50%.

*See Composite Catalog*

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Now Made of PBX Synthetic Rubber . Oil and Weather Resistant

# NEW SAFETY 100-OCTANE AVIATION FUEL

By **JOHN H. KUNKEL,** *Refinery Editor*

***Fuel has substantially the flash point of kerosine and the power characteristics of 100-octane aviation gasoline.***

**EXCLUSIVE** A NEW safety aviation fuel for use in the spark-ignited fuel injection-type aircraft engines that has, substantially, the flash point of kerosine, and all the power characteristics of 100-octane aviation gasoline, was introduced in New York on July 19 by technicians of the Standard Oil Development Company in a spectacular demonstration. Because of the new fuel's inherent safety features, it is hailed by aircraft engineers as one of the most important technical contributions to aviation, and its postwar use in commercial aviation is predicted as extensive.

The new fuel has a flash point of 105° F., as contrasted with 100-octane gasoline which has a flash point of minus 40°F.; yet, the new fuel packs all the punch of 100-octane. In flash point, the new fuel is somewhat like kerosine, and its safety factor is found in this characteristic. A half century's experience has demonstrated that a flash point of 100°F. is the dividing line beyond which danger from accidental leakage, or spillage, is negligible. Produced by the hydrogenation process, the new fuel, due to its high flash point, will not develop an inflammable envelope of vapors when exposed to ordinary atmospheric temperatures in the manner of gasolines. Thus, it makes safe the refueling of planes in flight, reduces greatly the fire hazard in ground refueling, and similarly the fire hazard from ruptured fuel tanks resulting from crack up.

The demonstration was in charge of E. V. Murphree, vice president of Standard Oil Development Company who talked of the new fuel's development and safety factors, while H. L. Thwaites of the research division conducted the various demonstrations, one of which involved placing a lighted cigarette above, and immersing it in, the new fuel without causing ignition.

● **Development.** The production of such a fuel interested Jersey Standard's technical group as early as 1932 when research toward its development was begun. Although there was no problem in raising the flash point of aviation gasoline to lower its volatility characteristics, and thus its rate of evaporation, two problems did present themselves. These were:

**1. The fuel would not function in conventional engines, because of the lower volatility, and,**

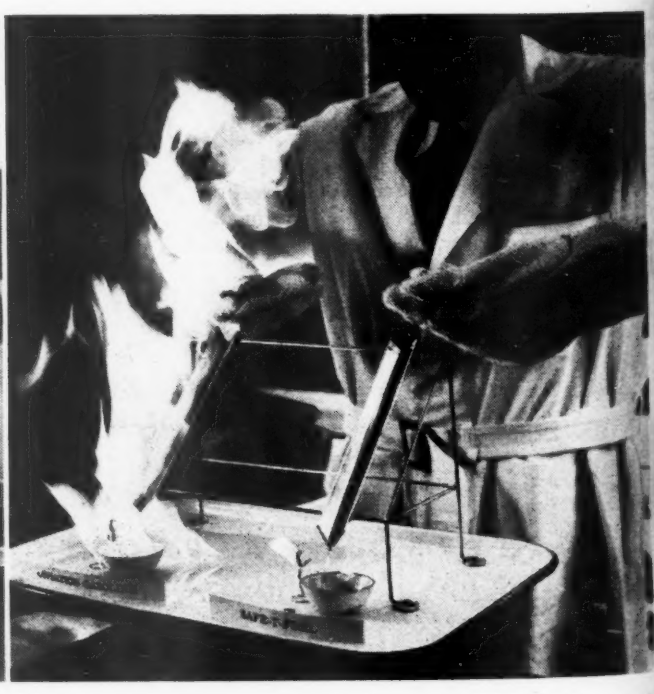
**2. Changing the volatility by ordinary refining methods resulted in a serious, and apparently unavoidable, loss in octane value.**

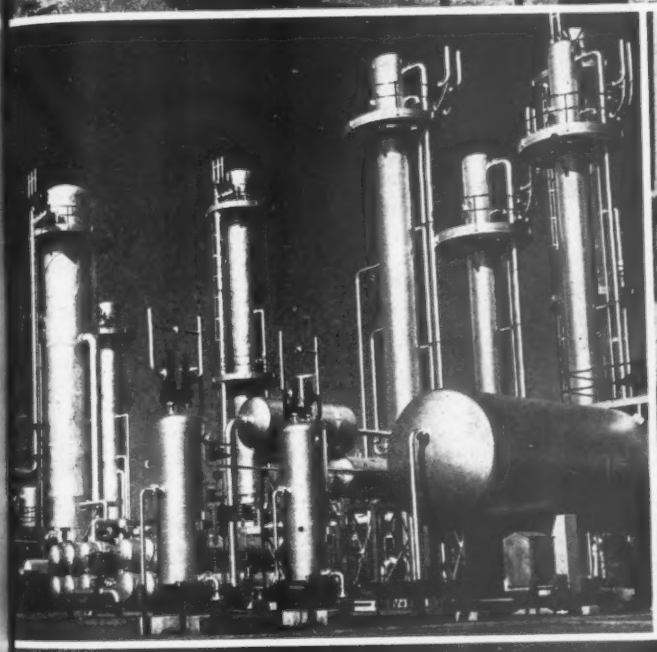
At the time, the lower volatility char-

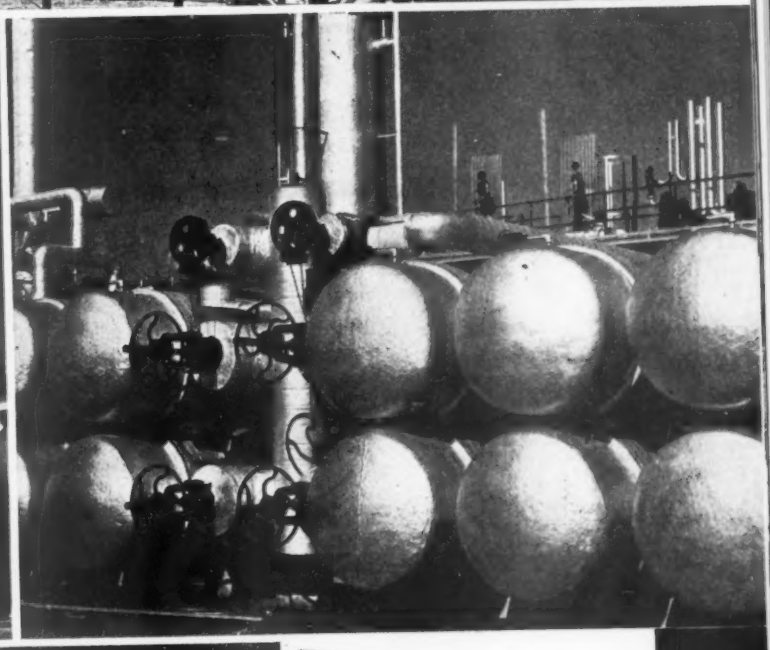
*(Continued on Page 176)*

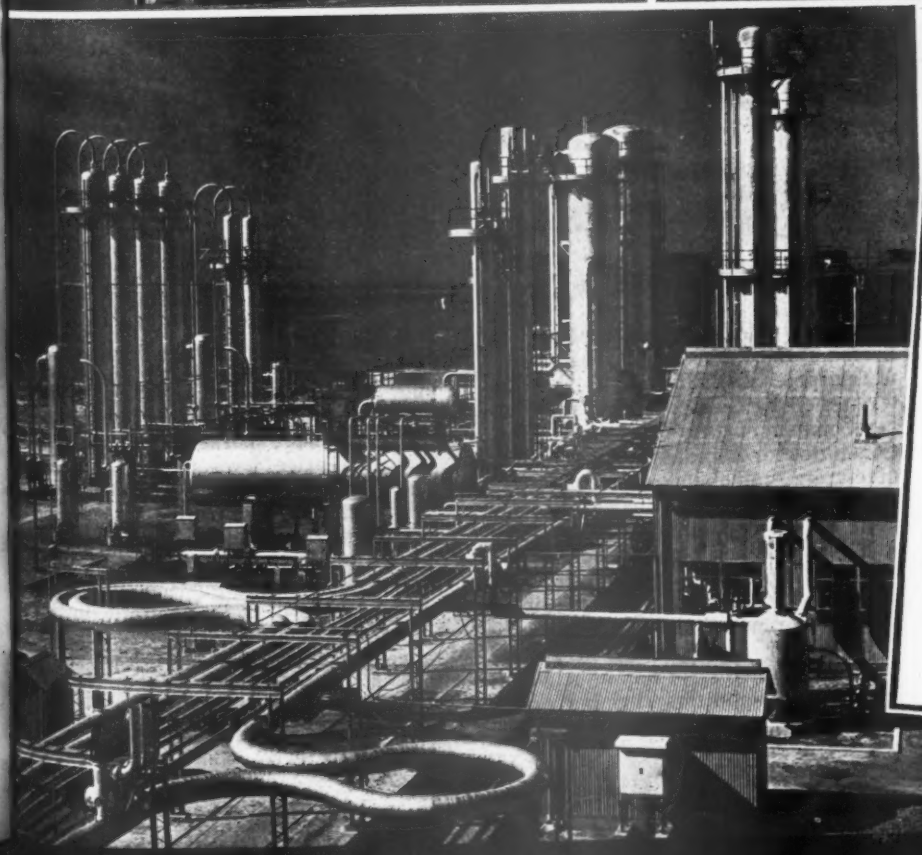
**High octane aviation gasoline floating upon water in glass at left blazes as its vapors burn when a lighted taper is held above it. When taper is stuck in glass on right containing safety high octane aviation fuel no fire occurs. The low volatility characteristics of the new fuel make it almost impossible to ignite until the liquid's temperature has been raised above 100°F. Ordinary aviation gasoline flashes into flame as the taper is held near it for it vaporizes and forms inflammable mixture of vapor and air in temperature as low as 40°F. below zero.**

**A burst of flaming 100-octane aviation gasoline covers fuel chute as 4 cc. of gasoline are poured past burning wick. At right an equal amount of new safety aviation fuel does not burn at all as it is poured past flaming taper. If the small stream of safety fuel was poured directly upon the blazing wick the flame would be extinguished. The fuel does not form inflammable vapors until its temperature is raised above 100°F. H. L. Thwaites of the Standard Oil Company (New Jersey) Research Division, makes the demonstration.**

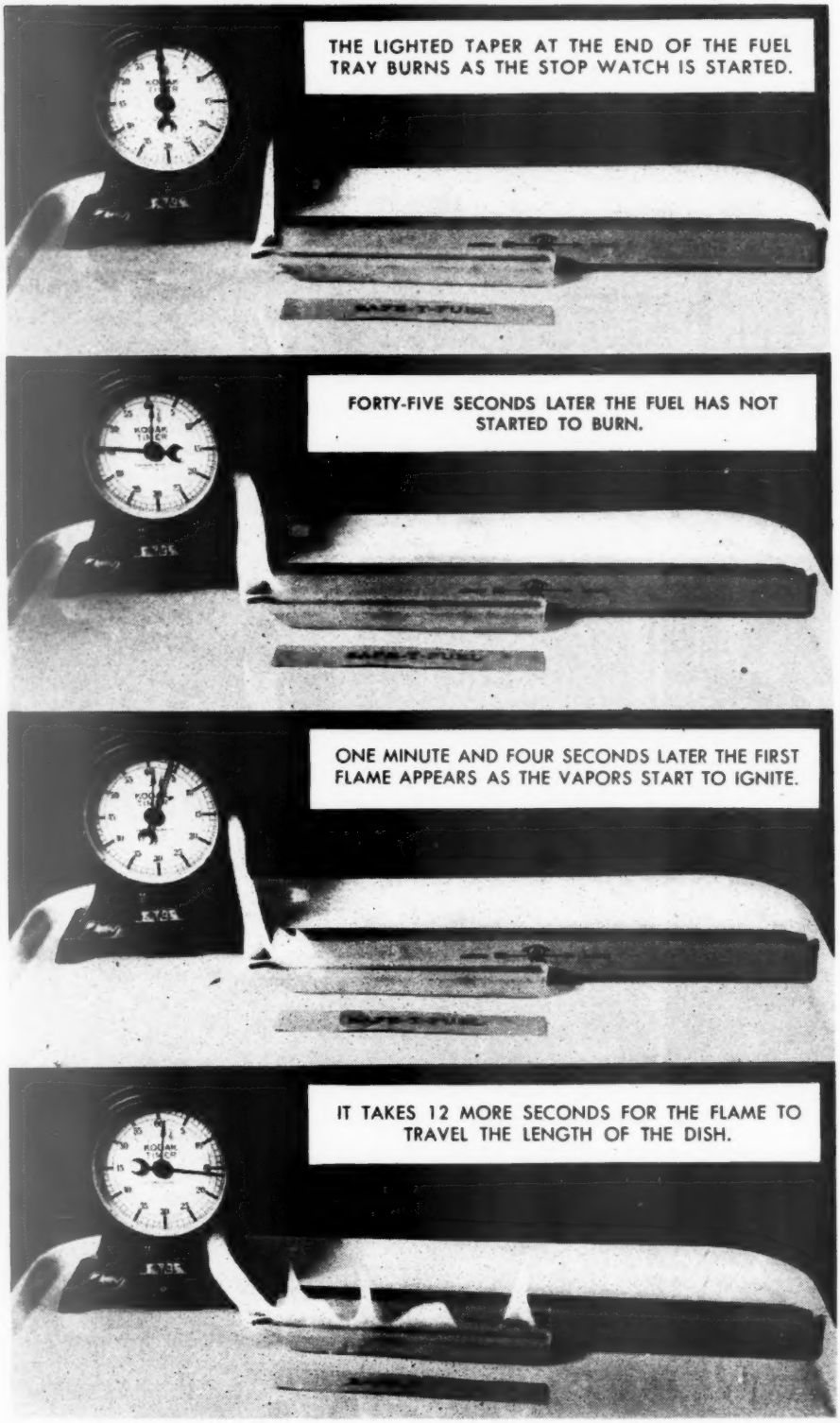








**WORLD'S LARGEST GAS RECYCLING PLANT, located near Houston, Texas, DESIGNED and BUILT by STEARNS-ROGER on a COMPLETE 'TURN-KEY' BASIS. An emphatic testimonial of our ability to serve the petroleum industry**


THE LIGHTED TAPER AT THE END OF THE FUEL TRAY BURNS AS THE STOP WATCH IS STARTED.
FORTY-FIVE SECONDS LATER THE FUEL HAS NOT STARTED TO BURN.
ONE MINUTE AND FOUR SECONDS LATER THE FIRST FLAME APPEARS AS THE VAPORS START TO IGNITE.
IT TAKES 12 MORE SECONDS FOR THE FLAME TO TRAVEL THE LENGTH OF THE DISH.

**Another advantage of the safety high octane fuel is that the rate at which an open flame spreads even after ignition is slow. A tray of safety fuel, a stop watch, and a ruler demonstrate this. If the fuel demonstrated was ordinary aviation gasoline it would instantly burst into flame as the taper was brought near it.**

*(Continued from Page 172)*

acteristics of the fuel seemed to call for either an entirely new type of carburetor, or a new type of engine.

The problem of obtaining high-octane value was solved, however, because, at that time the then new hydrogenation process came into being, and through its use, the new high-octane, high flash point fuel was produced. As is characteristic of a new fuel, its production cost was high, and the amount produced was small.

The fuel was of great interest to the U. S. Navy which, at the time, was doing considerable work with dirigibles, and, in 1932, a quantity of the fuel was delivered at the Bureau of Aeronautics for test purposes. In 1933 and 1934, the fuel was tested by Goodyear Tire and Rubber Company, by the National Advisory Committee for Aeronautics, and by manufacturers of fuel injection equipment. In March 1934, a plane fueled with high flash aviation gasoline was flown at Roosevelt Field on Long Island.

It was immediately apparent, from experimental use, that in order to obtain good performance under flying conditions further developments in special types of carburetors, or fuel injection direct to the combustion chamber of engines was required. These developments were slow, and the commercial application of the new fuel was further retarded by the excessive cost of its manufacture and the lack of refining equipment suitable for its volume production.

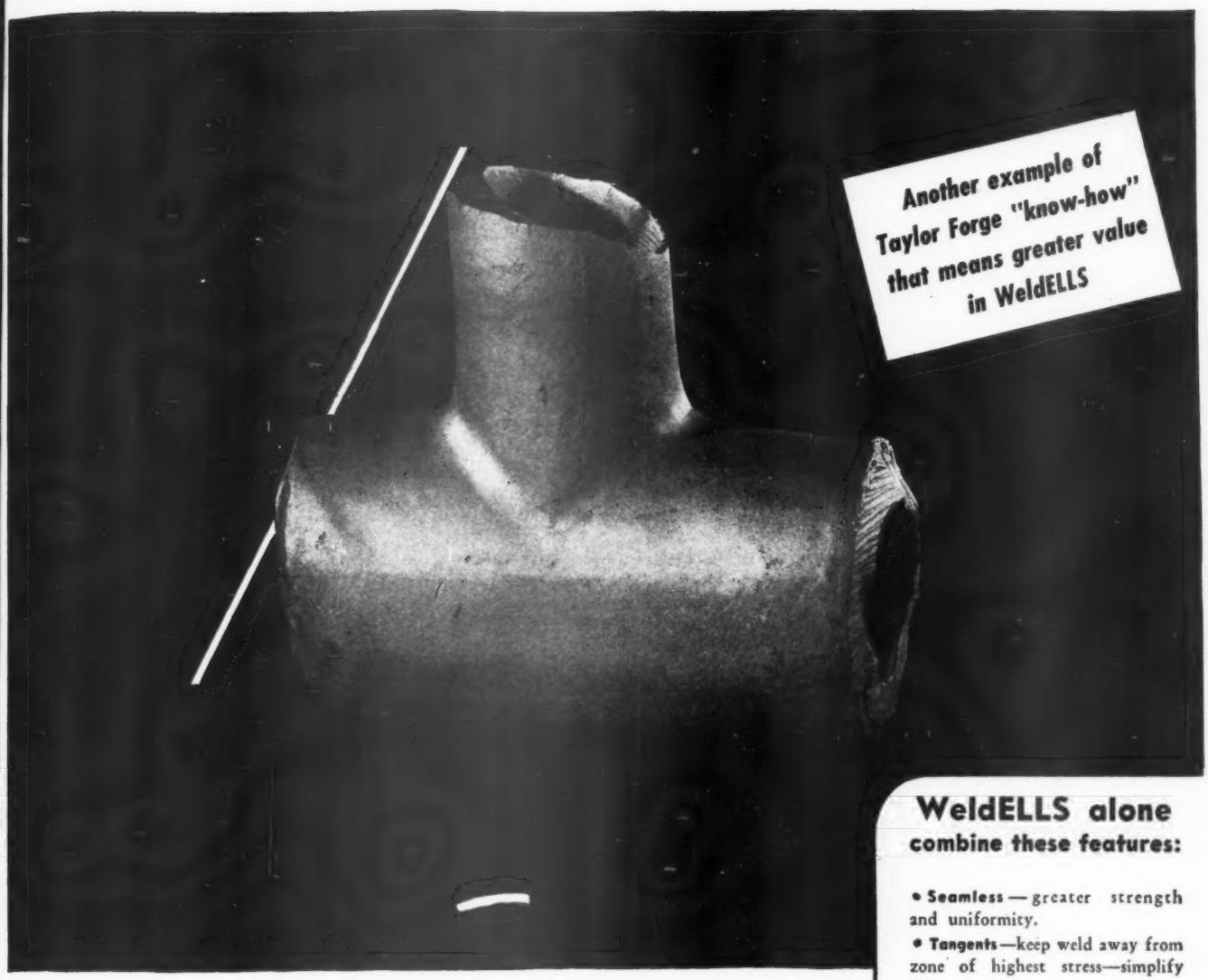
● **Wartime role.** In 1937, the U. S. Army Air Corps tested the fuel under combat conditions. These tests were continued over a period of years, and, recently, led to new and unexpected complications. In the case of 100-octane aviation gasoline, vapors above the fuel line inside the tank are too rich for combustion, and, therefore, will not burn when the tank is pierced by an incendiary bullet. However, when 100-octane leaks from such a tank, the vapors become highly inflammable.

The vapors above the fuel line of a tank filled with the safety fuel likewise are too rich for combustion, but it was found that, when an incendiary bullet pierced the tank, it probably sufficiently atomized the fuel in the vapor space and an explosion, similar to a dust explosion in grain storage silos, resulted. Although this fact eliminated use of the fuel in combat, it does not affect its peace-time values in commercial aviation, for, obviously, incendiary bullets will not be encountered.

The role the fuel was to play during the war was discovered in 1937 when the Navy selected it for testing fuel lines, fuel pumps, and storage tanks on aircraft carriers. Since the outbreak of the war, the fuel has been used by the Navy for these purposes and it has been possible to locate any leaks without incurring the danger of filling aircraft carrier compartments with highly combustible vapors. The hazards of such testing are consequently reduced to a minimum. As the new fuel blends perfectly with 100-octane gasoline, it has not been necessary to blow down the lines, etc. after testing before placing them in service.

Prior to the war, the high cost of producing the fuel limited its use. By 1936, advances in manufacture made it possible to produce the fuel at lower cost, and, although the fuel is presently produced in relatively small quantity, the vastly expanded market in postwar will bring its price level to a point only slightly higher than that of 100-octane.

With the postwar conversion of commercial aviation engines for direct fuel injection, and the development of aviation engines employing fuel injection, the new fuel will make safe refueling in the air possible, and, thus extend long range flying operations, and, at the same time, it will similarly contribute to the safety of ground operations.




★ *A few months ago we pictured in this publication a heavy-wall tee with a remarkably long outlet—so long in fact that a few of our friends were a little skeptical and implied that we had perhaps over-extended our poetic license, as well as the outlet, in retouching the photo.*

*Well . . . this one, as you can plainly see, is not retouched. The tee was photographed before machining just to show what can be done with hot metal if you know how.*

YES, "*if you know how.*" . . . And it will pay you to keep this matter of "know-how" in mind when you choose standard welding fittings. The need for unusual knowledge and highly specialized skills may be less apparent in regular fittings than in specials like this, but make no mistake: it is *no less essential.*

That is why we have cited this and many other unusual jobs which testify so eloquently to the "know-how" of Taylor Forge. This knowledge has enabled us to put into WeldELLS and other Taylor Forge welding fittings every feature wanted by everyone from the pipe designer to the welder.

In fact, you will see the evidences of this in every WeldELL . . . in the strength features like the selective distribution of extra metal where strains are greatest . . . in the convenience features like the tangents, the quarter-marked ends, the machine-tool bevels, the extremely accurate dimensions. Indeed, you will see that

**WeldELLS have everything**

## WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
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- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
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- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
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# The Hugoton Gas Field*

By E. G. DAHLGREN†

HUGOTON, the world's largest dry gas field, discovered in 1922, is the most active gas area in the nation from the standpoint of drilling activity. The tri-state Hugoton-Guymon field extends approximately 150 miles in length from its northern extremity in southwestern Kansas across Texas County, Oklahoma, to the present southern terminus in Sherman and Hansford counties in Texas.

On May 1, the field was classified as a "restricted area" by the Petroleum Administration for War on account of the materials shortage. With approximately 140 unconnected wells in the field it was deemed necessary to curtail drilling. Approximately 96 wells are being drilled (June 10) with 56 operations in Kansas, 16 in Oklahoma, and 24 in Texas. Exceptions to the drilling ban will be granted only by PAW. It is expected that restrictions will be lifted when the materials situation improves. The latest tabulation on completed wells (June 10) shows 741 gas wells with 448 in Kansas, 229 in Oklahoma, and 64 in Texas.

Various estimates have been made of the probable size of the field. As of January 1, 1945, the developed acreage of the field was as follows: Kansas, 220,094 acres; Oklahoma, 110,000 acres, and Texas, 22,400 acres. The total developed acreage of 352,494 acres is less than 10 per cent of one estimate of 3,850,000 acres for the entire field. The estimate of 3,850,000 acres or 6010 square miles is equivalent to the combined area of Connecticut and Rhode Island. Wells are being drilled on a pattern of one well to 640 acres. It is doubtful whether the entire field will be drilled up. About 850,000 acres, with an estimated reserve of 4,000,000 cu. ft. per acre along the fringes of the present estimated outline of the field, are considered non-commercial for drilling at the present time.

About 1,600,000 acres are considered to be in the "fairway" or the best part of the field. Reserve estimates vary from 20 to 26 trillion cu. ft. for the entire field.

As of January 1, 1945, the total gas production of the field was approximately 516 billion cu. ft. The Kansas portion of the field has produced nearly 434 billion with Oklahoma production at 81 billion. The Texas portion has produced a little more than a billion cubic feet with development getting under way last year.

The largest gas well is the Southwestern Public Service Company's Safranko No. 1 well located in Sec. 1, T. 3 N., R. 14 ECM in Texas County, Oklahoma. This well was completed with an initial production of 52,980,000 cu. ft. This well also enjoys the distinction of having the largest total production with a total of 4,559,000,000 cu. ft. up to January 1, 1945. Many other wells have total recoveries from 2 to 3 billion cu. ft. at the same date.

It is interesting to note the following average initial production per well: Kansas, 12,000,000 cu. ft.; Oklahoma, 19,500,000 cu. ft, and Texas, 12,900,000 cu. ft. These figures are on a daily basis.

In checking into the early history of the field, the first deep well in southwestern Kansas was drilled by the Traders Oil Corporation on the Boles farm, located in Sec. 3, T. 35 S., R. 34 W., a few miles west of the town of Liberal in Seward County, Kansas. The well was started in 1919 and reached a depth of 2919 ft. by the summer of 1920. No oil was reported, but gas showings were found between 2581 and 2755 ft. The hole was plugged back to the latter depth and completed in December, 1922, for a gas well with an open flow volume estimated at 5 to 10 million cu. ft. per day. This well is considered by many to be the discovery well.

During 1922 the Home Development Company drilled Allison No. 1, Section 4, T. 1 N., R. 12 E., Texas County, Oklahoma, to a depth of 3040 ft. Gas was found at about 2700 ft. and the well supplied the nearby town of Texhoma with gas for a number of years. In 1924 the Seward Oil and Gas Company completed Seeley No. 1, Sec. 20, T. 23 S., R. 33 W., Seward County, Kansas, at 2764 ft. for a small gas well.

IN 1926 an oil exploration campaign occurred in Texas County, Oklahoma, with 7 test wells being drilled. The Wilcox Oil and Gas Company's Hovey No. 1, Sec. 21, T. 4 N., R. 14 E. was plugged back and completed as a gas well, with a reported volume of 4,700,000 cu. ft. As a part of this exploration campaign, W. M. McKnab and the Independent Oil and Gas Company commenced the Crawford No. 1 in Sec. 31, T. 33 S., R. 37 W., in Stevens County, Kansas. After more than a year of drilling, gas was discovered in May, 1927. The well was drilled to 3502 ft. and then plugged back to 2620 ft. where it was completed for a reported daily initial open flow of 6,000,000 million cu. ft. and a rock pressure of 435 lb. Several consider this well as the discovery well of the Hugoton-Guymon field. Three more wells were drilled in 1928 and 1929. By the end of 1930, a total of 108 gas wells were drilled in Stevens and Morton counties in Kansas. Lack of markets and the depression resulted in about 25 wells drilled in Kansas from 1930 until 1936 when 26 wells were drilled. In Texas County, Oklahoma, only 9 wells were drilled up until 1938, when the Republic Natural Gas Company began developing its holdings.

The rocks that form the gas reservoir of the Hugoton-Guymon field are the dolomite beds of the lower part of the Sumner group and the dolomite and limestone beds of the upper part of the Chase group. The Sumner and Chase groups are part of the Big Blue series of the permian system. Garlough and Taylor[1] have sub-divided the groups into three gas producing zones separated by red shale beds. The first zone is known as the Herington, which has a thickness of 100 to 120 ft. The middle zone is the Winfield limestone, which has a thickness of about 40 ft. The Towanda, Fort Riley, and upper Florence limestones are believed to comprise the Fort Riley zone with a thickness of about 100 ft. The total thickness of the three zones is about 250 ft., but the thickness of actual gas-producing formation is much less.

The structural attitude of the gas-producing rocks is that of a generally eastward dipping homocline or monocline. The Winfield limestone is more than 800 ft. above sea level at the west edge of the field and 300 ft. above sea level at the east edge. The field is generally considered a stratigraphic trap with the gas being trapped by the pinching out westward and northwestward of the gas bearing rocks and their replacement by relatively impermeable red shale and siltstone.

The rock pressure of the field is subnormal. In the early days of its development the initial pressure was commonly considered to be 440 lb. per sq. in. An examination of the March, 1945, allowable schedule of the Kansas Corporation Commission shows present pressures ranging from 370 to 420 lb. The lowest pressure listed was 356 lb.

Rotary drilling tools are usually used from the surface to approximately 2450 ft. or near the top of the Herington dolomite where the first gas is generally en-

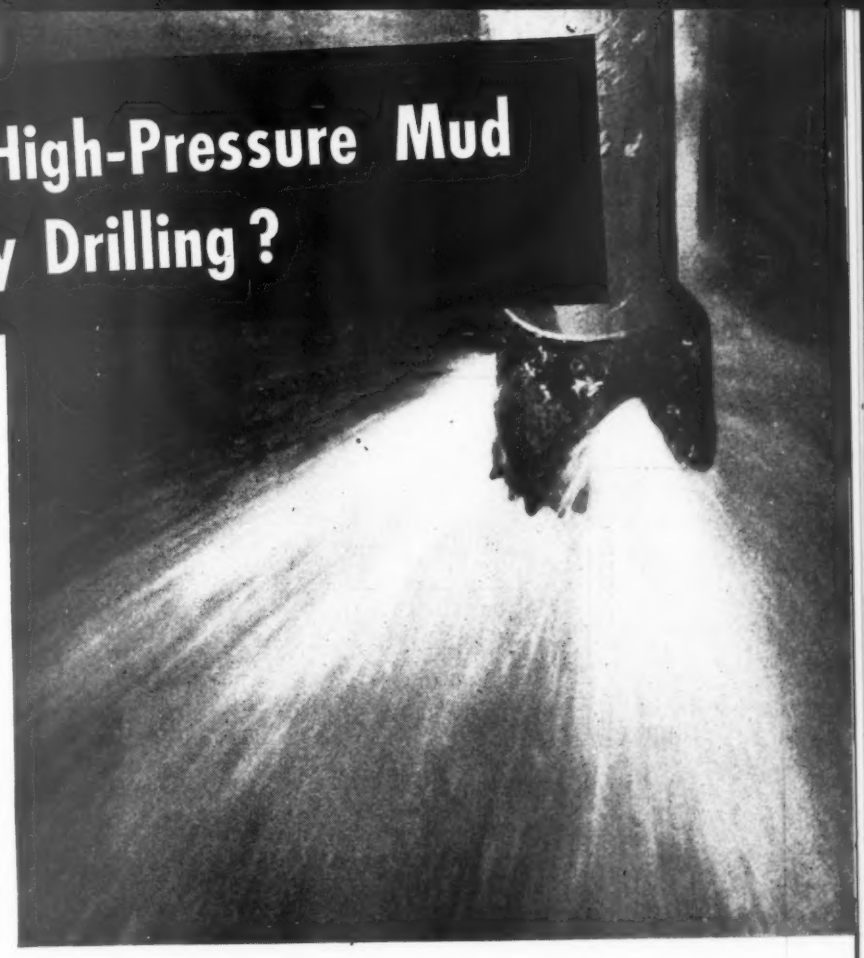
*This article was prepared for publication in the *Quarterly Bulletin* of the Interstate Oil Compact Commission.

†Assistant Secretary, Interstate Oil Compact Commission, Oklahoma City, Oklahoma.

[1]John L. Garlough and Garvin L. Taylor. "Hugoton gas field, etc." Stratigraphic Type Oil Fields. AAPG Bulletin, Dec. 1941, P. 78.

***World's largest dry gas field is also the most active gas area from standpoint of drilling.***

# Does High-Volume, High-Pressure Mud Speed Rotary Drilling?



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As more and more drillers switch to high-volume, high-pressure slush pumps, we get increasingly favorable reports. Some have obtained more than double the usual footage per hour!

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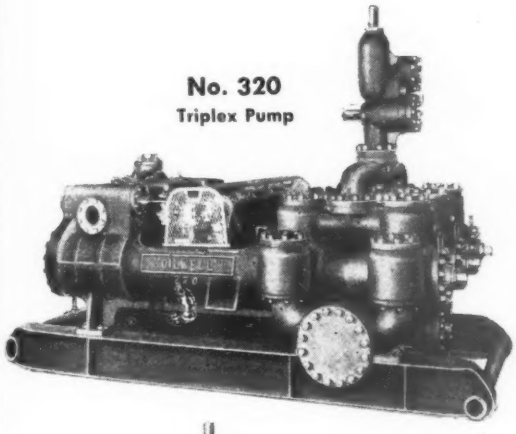
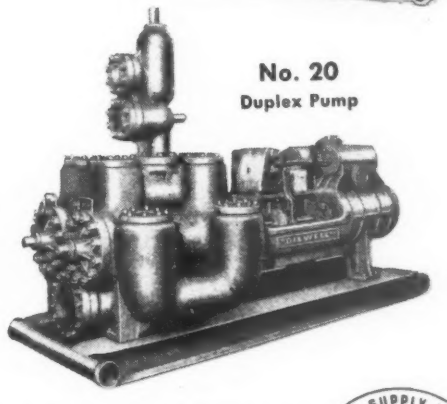


No. 320
Triplex Pump



No. 20
Duplex Pump

**The "Oilwell" No. 320 Triplex Pump has a ratio of 6.62 to 1**

**The "Oilwell" No. 20 Duplex Pump has a ratio of 4.39 to 1**

Because of their ability to turn ordinary steam pressures into extraordinary "mud power," these two "Oilwell" steam-driven slush pumps are the logical choice where high-pressure drilling is encountered or where high-speed results are desired.

Each model has its own inherent advantages, but within their respective performance ranges, either pump can be depended upon to play a major part in getting additional footage every hour . . . with more drilling hours between every change of bits . . . and that spells "Extra Profit" for the owner.

*Ask your "Oilwell" representative for detailed information and specifications*

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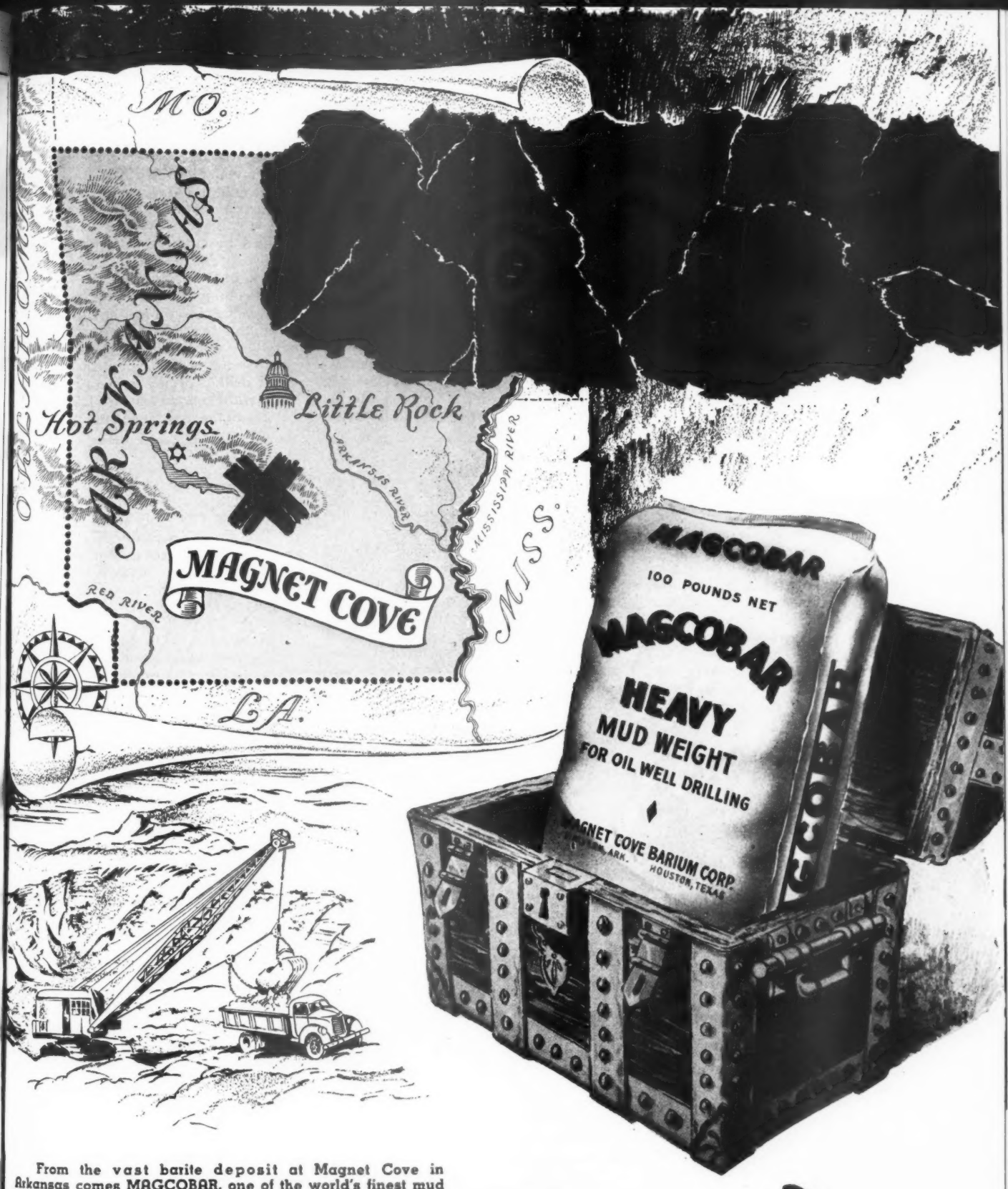


From the vast barite deposit at Magnet Cove in Arkansas comes MAGCOBAR, one of the world's finest mud weights for oil well drilling. Its exceptional purity gives high weight, low viscosity muds that can be maintained at minimum cost while drilling.

The barite deposit at Magnet Cove was discovered many years ago, but all early attempts to mine this mineral ended in failure. It was not until 1939, when the producers of MAGCOBAR developed a process for beneficiating the ore, that this treasure of nature became useful to man. The development of this deposit has proved most timely. During the past two years when barite mud weight has been critically short, due to an increased need for oil to meet the demands of war, two-thirds of all the mud weight material used has come from the Magnet Cove barite deposit. This new source of mud weight not only prevented an acute war-time shortage, but it has reduced the long prevailing market price of this commodity by one-half, resulting in a saving to the oil industry of more than $4,000,000.00 annually.

Surely, MAGCOBAR is a real treasure for the oil industry!

# Magcobar

*Complete*

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**MAGNET COVE BARIUM CORP.**

**Malvern, Arkansas** **Houston, Texas**

countered. After the producing string is run, cable tools are usually used to complete the well.

In the past year some wells have been completed with rotary tools. Pipe has been set on bottom and gun perforated in the gas zones. From 500 to 600 ft. of surface casing is run and cemented to protect the fresh water zones and from 2300 to 2700 ft. of casing is run for the production string. No tubing is used as the wells make very little, if any, water.

As the producing zones may be distributed through a vertical distance of approximately 400 ft. all open hole, some wells have the operating problem of having the softer formations subject to caving, thereby shutting off the gas flow. Clean out tools are used to remedy wells troubled with cavings. Nearly all the wells drilled recently have been acidized before completion. From 5000 to 25,000 gal. of acid in several stages have been used with excellent results in increasing the open flow volume.

The Northern Natural Gas Company in 1930 provided the first pipe line outlet in the Kansas portion of the field. (See Table 1.) This line extends to Omaha, Nebraska, and Minneapolis, Minnesota, and serves at wholesale about 200 communities in Nebraska, Iowa, South Dakota, and Minnesota. The Northern Natural Gas Company has taken over the operation of the Argus Natural Gas Company's 8-in. line that supplies Garden City and Dodge City, Kansas, and intermediate towns.

The Liberal Gas Company has a 6-in. line that supplies the city of Liberal, Kansas.

The Panhandle Eastern Pipe Line Company with a main 24-in. line with numerous loops supplies gas to Missouri, Illinois, Michigan, and Ohio. The Federal Power Commission recently granted a request for additional facilities to supply more gas for war industries in the the East.

The Tri-County Gas Company has two 6-in. lines extending to Scott City, Kansas, where these lines hook up with the line of the Kansas-Nebraska Natural Gas Company, which extends to central and western Nebraska. The line also serves about 20 Kansas communities.

The Central Gas Utilities Company 6-in. line supplies gas to Lamar, Colorado, and adjacent cities in Colorado.

One of the big factors in the development of gas production in Texas is the completion last year of the 26-in. line of the Cities Service Transportation and Chemical Company. The Federal Power Commission has recently granted permission to the Cities Service Gas Company to purchase this line. This line extends from a compressor station north of Guymon for a distance of 230 miles to Blackwell, Oklahoma, where the line connects with the system of the Cities Service Gas Company. A gathering system has been built to connect the wells of the Cities Service Gas Company. The Cities Service Company nominated a total of 190,000,000 cu. ft. per day in June through this system on a 2-lb. base.

The Republic Natural Gas Company owns its own gathering system, which consists of a 67-mile loop of 14-in. pipe line. The Republic line gathers gas from its own wells and delivers it to the Northern Natural Gas Company.

The Peerless Gas Company and the United Carbon Company with small gathering systems supply gas for two carbon black plants in the field. The Peerless plant near Hickok in Grant County, Kansas, has a daily capacity of 3,800,000 cu. ft. The United Carbon plant in Ryus, Grant County, has a daily capacity of 23,000,000 cu. ft. The Cabot Carbon Company plant at Guymon, Texas County, Oklahoma, has a daily capacity of about 16,000,000 cu. ft. The Cabot Company has been recently granted an application to build a channel process plant of 30,000,000 cu. ft. capacity. The Cabot Company also supplies about 6,000,000 cu. ft. of gas to the General Atlas Carbon Company plant in Texas County.

In Texas County, Oklahoma, the Southwestern Public Service Company serves Guymon and other communities through its gathering and distribution system.

The Phillips Petroleum Company gathers gas from its wells and delivers the gas to the Panhandle Pipe Line Company system at its Hansford station, where gas is also received from the Phillips properties in Hansford and Sherman counties in Texas. The Republic Natural Gas Company has extended its gathering system into Texas County.

Three natural gasoline plants are located in the field. The two Kansas plants are the Panhandle Eastern Pipe Line Company plant at Arkalon near Liberal, and the Northern Natural Gas Company plant at Hugoton. The Panhandle Eastern plant has a daily capacity of 275,000,000 cu. ft., and the Northern Natural plant has a daily capacity of 100,000,000 cu. ft.

The new Phillips Petroleum Company plant in Hansford County, Texas, has a daily capacity of 60,000,000 cu. ft. The natural gasoline content of the gas is about 0.035 gal. per 1000 cu. ft.

An average analysis is as follows:

| | Per cent |
|---|---|
| Methane | 74.26 |
| Nitrogen | 14.27 |
| Ethane | 5.81 |
| Propane | 3.53 |
| Butane | 1.48 |
| Pentane plus | 0.65 |

The gas is uniformly sweet throughout the field with the exception of a small area in Sherman County, Texas, where the sulphur content ranges from 6 to 30 grains per 100 cu. ft. The B.t.u. value averages about 1050.

In common with large oil and gas fields, conservation and proration have been problems in this gigantic gas field. Surface wastage has never been a severe problem as there has been no oil production and no combination oil and gas wells as in the Panhandle gas field in Texas. About the only surface wastage in the past has been the blowing of gas wells to condition them for production tests.

The lack of markets and the problem of unconnected wells have been the chief irritants in trying to insure ratable taking and equity in withdrawals. Until 1936, wells were drilled on spacing of 1 well to 160 acres, but since 1936 all wells have been drilled on 640-acre spacing.

The Kansas portion of the field is being regulated under the provisions of the basic order issued March 21, 1944. This basic order rescinded and superseded the prior basic order dated October 28, 1942. The 1942 basic order superseded and rescinded the first basic order which had been in effect since January 30, 1940. Following the passage of the Natural Gas Law in 1935, attempts had been made to investigate the application of the law to the Hugoton field, but no hearings were held until 1938.

An examination of the basic order shows that the basic acreage unit in the proration formula is 640 acres. The acreage factor is the production of the number of acres attributable to a well divided by 640. Completed wells, with less than 640 acres, may include non-contiguous acreage located within a 2-mile radius. A hearing may be held to determine whether non-contiguous acreage within a 3-mile radius from a well may be included.

A lease is considered undeveloped until a gas well has been completed and the owner or operator has tendered gas

## Watson reviews South America prospects

R. E. Watson, vice president of the Drilling and Exploration Company, Inc., Dallas, Texas, spoke recently on "Oil Operations in South America" before Petroleum Accountants Society.

Watson, who recently returned from Venezuela, pictured a vast and partly unexplored tropical country redundant in deep verdure, providing a source of venomous reptiles, rare tropical diseases, as well as drilling sites for fabulous oil fields producing in excess of 800,000 bbl. a day.

He dwelt further on the vastness of 393,000 square mile Venezuela and marked the contrast between the modern American type cities on the coast to the dense jungles, impenetrable swamps, unnavigable rapids, and great wide plateaus, inhabited by primitive tribes.

"It was on these vast tablelands that the mythical King Kong was supposed to have been found, which inspired other monstrous fabrications about the Venezuela plateaus," Watson said. He continued by crediting the rugged individualism of the oil operators for coordinating industrial procedure with local governmental policies in developing the fabulous natural resources and making them available to the world. The development of these almost inaccessible natural resources has been accomplished by American drillers working in close cooperation with Venezuealan professional men and with the assistance of local crews.

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to a purchaser at the purchaser's pipe line. Before a well is entitled to an allowable, the operator must establish a tendership by constructing a pipe line to the line of a pipe line company or other purchasing facilities, or by filing an affidavit that the operator is ready to construct a line to a purchaser and sell gas at the prevailing price in the field. If an operator is unable to sell his gas, a hearing may be held to determine the factors.

As the proration formula takes into consideration the deliverability factor, the deliverability of each connected well is determined by producing the well into the pipe line for approximately 72 hours, during which time the working pressure at the wellhead shall be maintained at 80 per cent of the average shut-in wellhead pressure of the field, or as closely thereto as operating conditions in the field will permit. The rate of flow is determined and the shut-in and working pressures determined in order to ascertain the deliverability. The deliverability of each unconnected well that is entitled to an allowable shall be estimated from its open flow and deliverability for all wells in the field.

A well's quota is determined by the following method: The proration factor for the field is determined by dividing the total field allowable by the sum of the products of deliverability times the acreage factors of all the wells in the pool. The field proration factor is multiplied by the product of the deliverability times acreage factor for the well to obtain the well's allowable. By way of illustration, the May allowable schedule gives the Central Gas Utilities Company Leonard No. 1 well a gross allowable of 47,831,000 cu. ft. This allowable was computed by multiplying the product of its deliverability of 4,955,000 cu. ft. and the acreage factor of 1.00 (for 640 acres) by 9.653012, the relationship of the total gross allowable for May to the sum of all the deliverability-times-acreage-factor products.

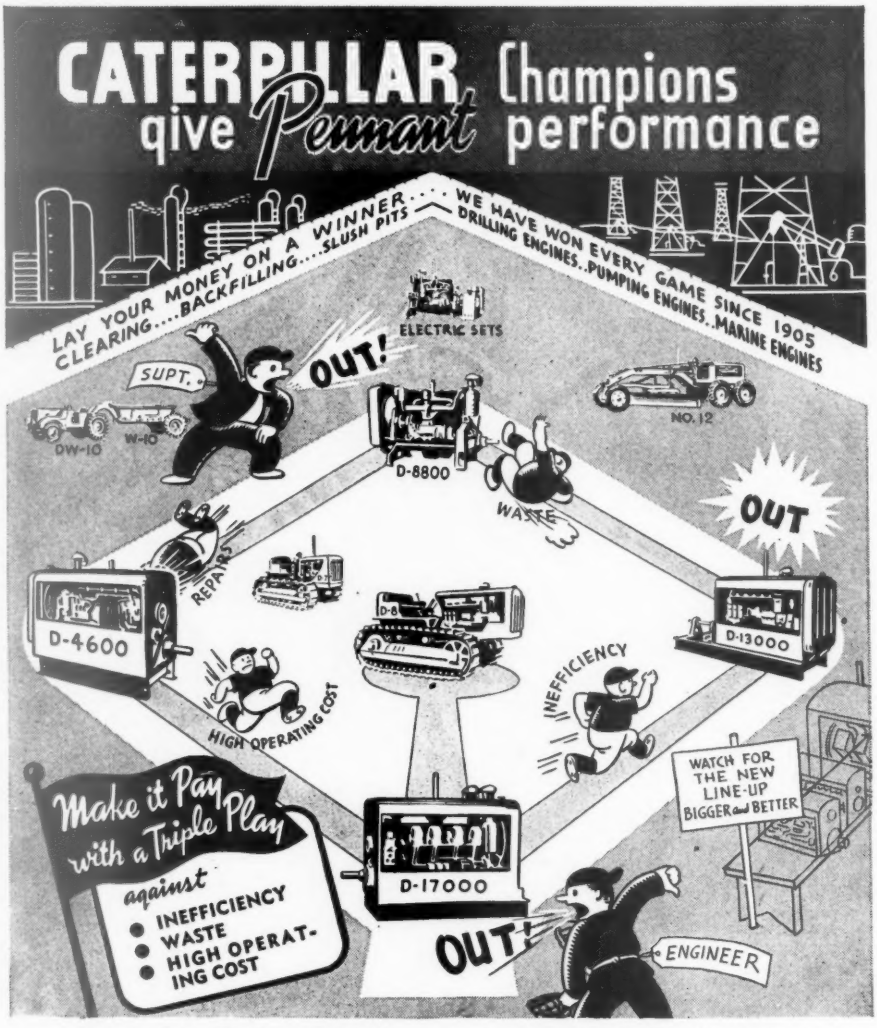
Two market demand hearings are held each year. The first hearing covers the period from October 1 and March 31, inclusive, and the second hearing covers the period from April 1 to September 30, inclusive. Emergency demands during each allowable period may be taken care of by ratable increases in allowables for all wells. Overages and underages at the end of allowable periods are carried over during the next period. All wells with overages in excess of three times their current allowables shall be shut in to make up overages. Underage will be canceled on wells with underages in excess of three times its current monthly allowable.

Deliverability tests and the 72-hour shut-in pressures of the wells are taken under the supervision of an engineer of the conservation division of the Kansas State Corporation Commission. It is interesting to note that the offices of the conservation division are in Wichita, whereas the State Corporation Commission office is at Topeka. A field engineer is stationed within the field.

Allowable schedules issued by the Oklahoma and Kansas Corporation Commissions show that the Kansas wells have a total deliverability of 715,094,000 cu. ft. or a per well average of 1,740,000 cu. ft. with the Oklahoma Total of 600,493,000 cu. ft. or a per well average of 3,639,000 cu. ft. Information on wells in Texas indicate a total deliverability of 186,700,000 cu. ft. or a per well average of 4,270,000 cu. ft. The field has a total deliverability of 1,502,287,000 cu. ft. per day at an operating pressure of 312 lb. gage. Deliverability determinations are not required in the Texas portion of the field.

The June market demand schedule of the Oklahoma Corporation Commission shows a total of 6,590,000,000 cu. ft. allocated among 165 wells. This represents a daily average of 219,666,000 cu. ft. The May allowable report of the Kansas Corporation Commission shows a gross allowable of 6,290,878,000 cu. ft. or daily average of 202,931,000 cu. ft. These allowables are based upon nominations filed by the purchasing companies. No nominations have been required from the Texas portion of the field, as the only restriction is that production be held to within 25 per cent of the open flow capacity of the wells.

Pipe line data for April indicate that a total of 6,532,984,000 cu. ft. were pur-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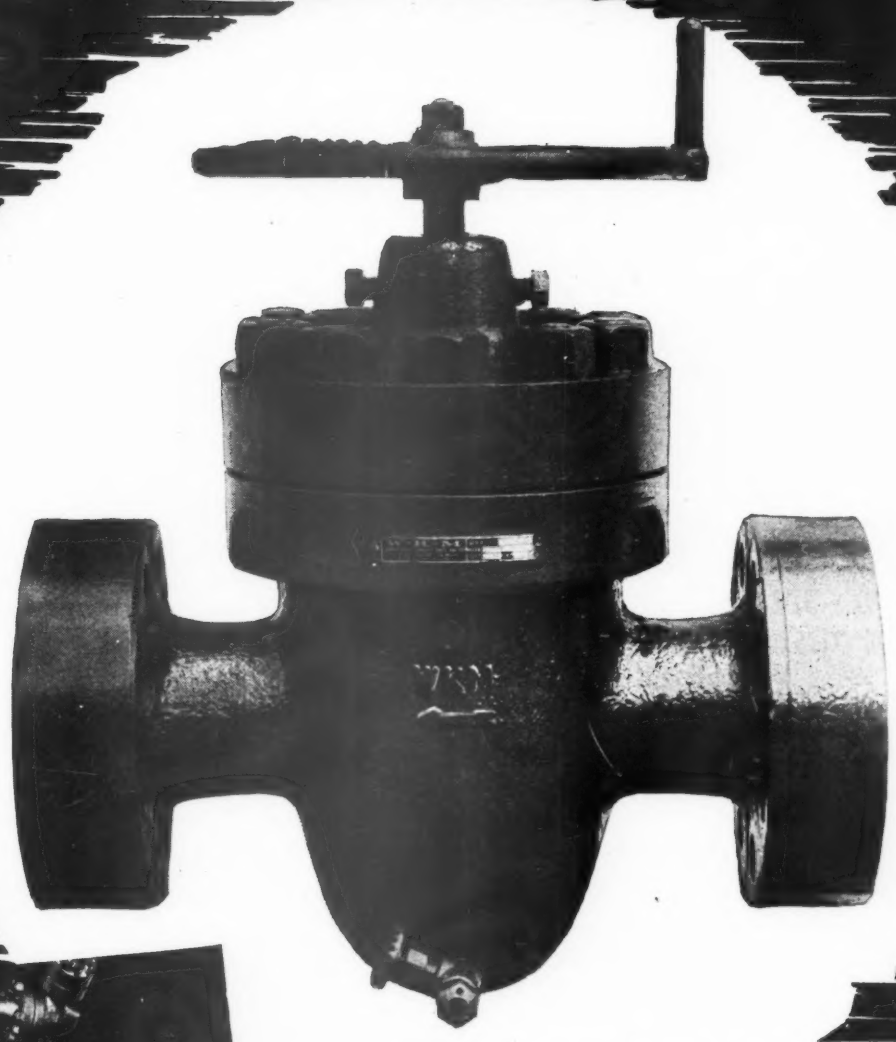

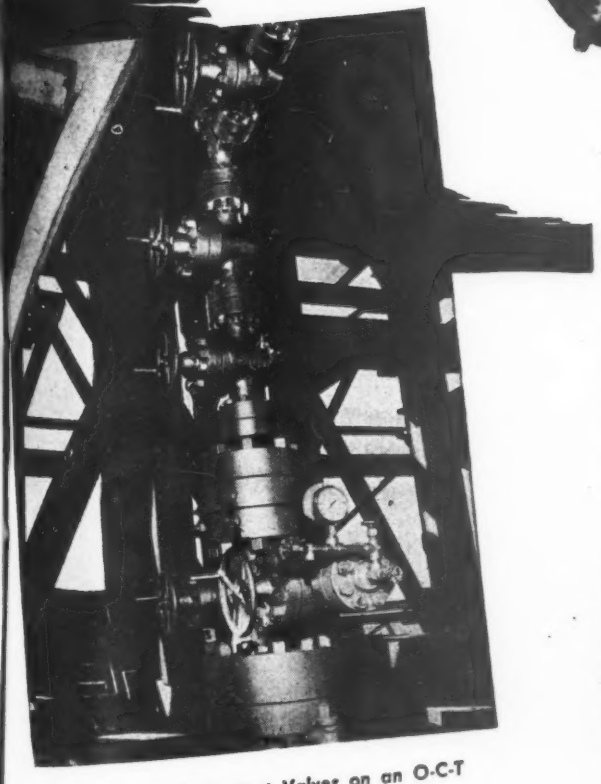

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chased from the Kansas portion of the field or a daily average of 217,432,000 cu. ft. The Oklahoma portion of the field sold a total of 6,581,000,000 cu. ft. in April or a daily average of 219,666,000 cu. ft. Data on the Texas portion sales for April indicate a total 1,130,864,000 cu. ft. or a daily average of 37,693,000 cu. ft. A grand total indicates total sales for April as 14,244,848,000 cu. ft. or a daily average of 474,828,000 cu. ft.

The Oklahoma portion of the field is being regulated by order No. 17867 in Cause CD No. 983 of the Oklahoma Corportion Commission. Rules and regulations were originally established in order No. 16377 issued on May 5, 1943. Order No. 17410, issued on December 27, 1944, contained a declaration of policy that rules and regulations be promulgated to prevent waste in production, to provide ratable taking, a uniform method of determining natural flow, and to allow each operator to produce his share of the gas and to produce ultimately the amount of gas originally underlying his land. This policy is essentially the same as that of Kansas.

Details of the order pertaining to allocations and the determination of deliverability, acreage factors, etc., are practically the same as in Kansas. Acreage units are limited to 640 acres except that short sections near the Kansas-Oklahoma line may be communitized with adjoining 640 acre sections after a hearing to form units of not more than 800 acres.

**TABLE 1.**

**Pipe line outlets from Hugoton gas field.**

NORTHERN NATURAL GAS COMPANY, Omaha—Serves 200 communities in Nebraska, Iowa, South Dakota, Minnesota. Terminus of line: Minneapolis and St. Paul, Minnesota. Through acquisition of Argus Natural Gas Company also serves Garden City and Dodge City, Kansas, through 8-in. line.

PANHANDLE EASTERN PIPE LINE COMPANY, Kansas City*—Through almost completely looped 24-in. line serves communities in Missouri, Illinois, Ohio, Michigan. Terminus of line: Detroit.

KANSAS-NEBRASKA NATURAL GAS COMPANY, Phillipsburg, Kansas—Serves gas at wholesale to 4 towns in Kansas, 40 in Nebraska. Distributes gas at retail in 21 towns in Kansas; 32 in Nebraska.

CITIES SERVICE TRANSPORTATION AND CHEMICAL COMPANY—Connects with system of Cities Service Gas Company, Bartlesville, Oklahoma, through 320-mile, 26-in. line from compressor station north of Guymon. Cities Service has received permission to purchase this line from the Federal Power Commission.

LIBERAL GAS COMPANY — Through 6-in. line serves Liberal, Kansas.

TRI-COUNTY GAS COMPANY—Through two 6-in. lines to Scott City, Kansas, serves a number of Kansas communities.

CENTRAL UTILITIES GAS COMPANY—Through 6-in. line serves Lamar, Colorado, and adjacent cities.

*FPC on April 3 granted a certificate of public convenience and necessity to Panhandle Eastern to construct and operate facilities to increase the company's 333,000,000 cu. ft. daily delivery capacity of its main line by 50,000,000 cu. ft. a day.

On May 31, 1945, the Oklahoma Corporation Commission issued its first order in accordance with House Bill 257 passed by the legislature this year and approved by the governor on May 5. This law gave the commission the authority to establish 640-acre spacing units. The May 31 order, No. 17867 in Cause CD 983, established well allowables effective June 1. Two market demand periods were established for each year. One period begins April 1 and ends September 30, whereas the other period begins October 1 and ends March 31. Market demand hearings will be held prior to these periods. Deliverabilities of the wells shall be determined between May 1 and September 30 each year. New tests will be taken beginning on July 1.

The June allowable schedule shows the Cities Service Gas Company as the leading producer with 95 wells with a total acreage of 60,800 acres and a deliverability of 360,615 cu. ft. The Cities Service June allowable is 4,024,121,000 cu. ft. The Republic Natural Gas Company has 47 wells with a total of 30,568 acres and a deliverability of 151,930 cu. ft. Its June allowable is 1,699,815,000 cu. ft.

Other companies listed are the Cabot Carbon Company with 7 wells, the Phillips Petroleum Company with 13 wells, the Southwestern Public Service Company with 2 wells, and the Peerless Oil and Gas Company with 1 well.

The June schedule shows 165 wells with a total of 104,740 acres and a deliverability of 600,493 cu. ft. The June allowable is 6,590,000,000 cu. ft. The report does not include 30 unconnected wells that have not yet established their right to an allowable. ★★★


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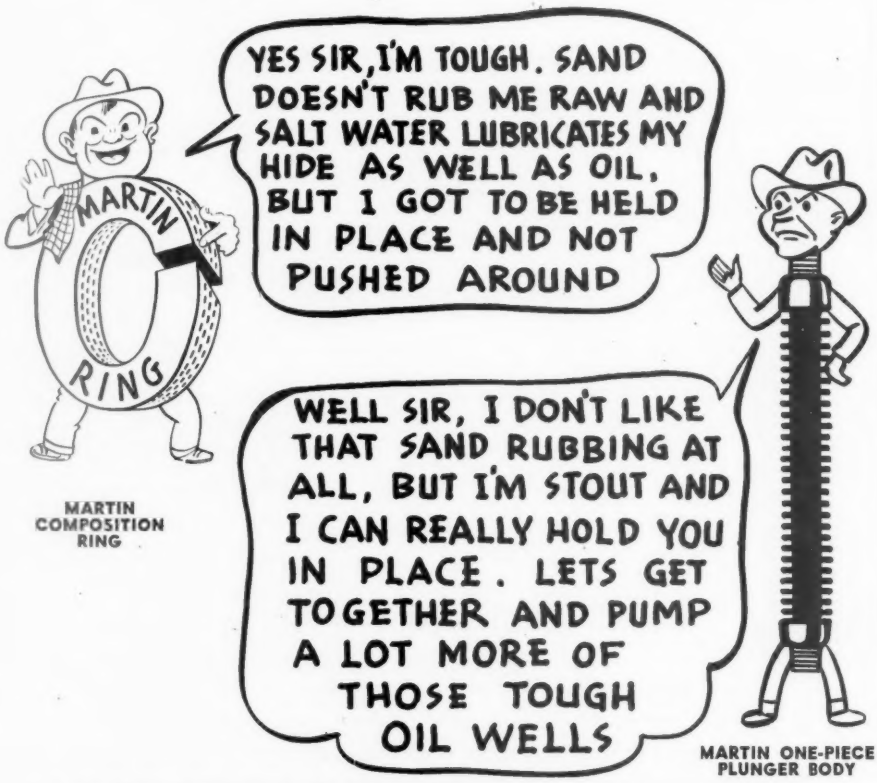
YES SIR, I'M TOUGH. SAND DOESN'T RUB ME RAW AND SALT WATER LUBRICATES MY HIDE AS WELL AS OIL, BUT I GOT TO BE HELD IN PLACE AND NOT PUSHED AROUND
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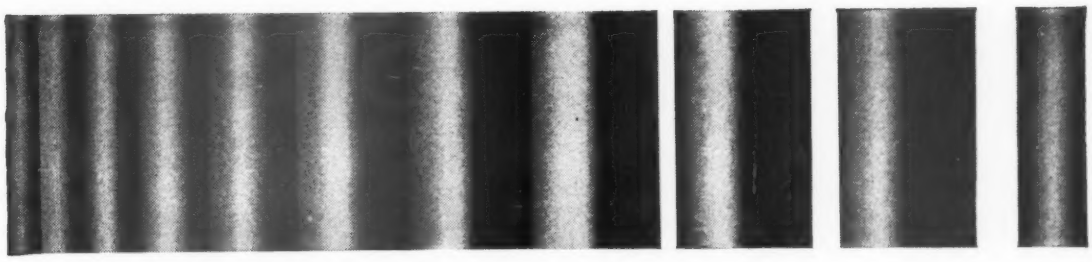

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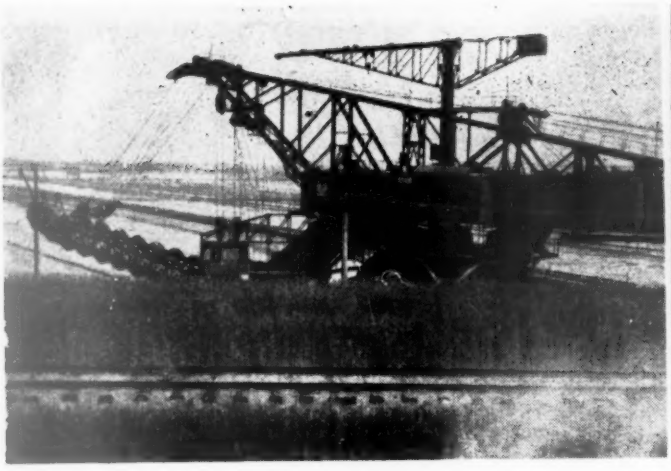
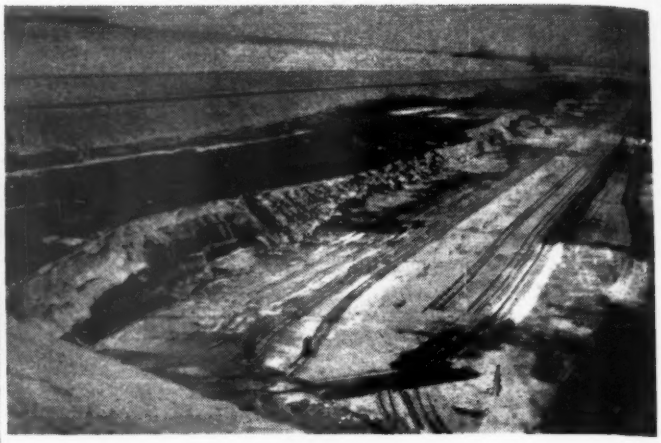


Bucket shovel used to strip overburden.



West side of coal pit, showing beds of coal. Giant shovel in background.

# GERMAN PLANTS EXTRACT GASOLINE FROM COAL

By **LEONARD C. HALPENNY***

Part of thirty large bricket-burning ovens. Absorption towers in foreground.

**EXCLUSIVE** ONE of the main sources of gasoline for the Wermacht and the Luftwaffe during the days of German supremacy in Europe was the "brown coal" pits of Saxony. During the period ending in late 1942, 40 per cent of all the gasoline produced in Germany came from these mines. After losing their oil fields, these coal pits were their only source of liquid fuel. The brown coal is converted into benzine, an unstable fluid of 60-65 octane, which must be blended with benzol to obtain a stable motor fuel of 75 octane. The benzol is obtained from anthracite coal, a little of which comes from the vicinity of Dresden, but most of which comes from the Saar and Silesian mines. The Germans have built very extensive plants for the conversion of coal to gasoline, many of them in the vicinity of Leipzig. The plants are in a chaotic condition at present, from having a very high priority on the Allied bombing program.

The Aktiengasellschaft Sächsischer Werke, Espenhain, about 12 miles south of Leipzig, is typical of these plants. It is primarily owned by the State of Saxony, and some people seem to think that is the same as being owned by the Hermann Goering group. The plant was started in 1938 and completed in 1939, at a cost of M400,000,000, at that time equivalent to about $100,000,000. The layout of the plant was modeled after a plant at Böhlen, built by the same organization in 1935. There are a few differences between the two plants, however: (a) The Böhlen plant is very crowded, having been added to several times, whereas the Espenhain plant is laid out over a larger area; (b) only one-third of the coal burned for fuel production at Espenhain is converted to benzine at that plant. The other two-thirds is piped to Böhlen in the form of teerantar, where it is converted to benzine; (c) The Böhlen plant supplies domestic and industrial fuel in the form of coal brickets to the surrounding countryside, and the Espenhain plant supplies electrical energy for most of the State of Saxony and part of Bavaria.

The Espanhain plant used 9000 metric tons of coal a day for benzine production, in addition to that used in the power plant, until production was curtailed by Allied bombing. From these 9000 tons, about 900-1000 metric tons (roughly 350,000 gal.) of benzine were obtained, a recovery of about 11 per cent. As the coal in the pits is, however, 53 per cent water, the recovery of benzine is about 5 per cent of the coal as taken from the ground. There were 6000 people employed in the plant during peak operation. The plant was operated normally on

**The author in Germany**

*Sgt. Leonard C. Halpenny of the 269th Engineer Combat Battalion interviewed the chief engineer of two of the largest synthetic fuel plants in Germany and went through the plants himself. The photos were taken with a captured German camera and film just before the sergeant's battalion was ordered to move back to let the Russians occupy the territory. A Canadian by birth, Halpenny moved to Texas in 1925, and was graduated in 1938 from the University of Texas. He was employed on the U. S. Geological Survey in Austin, Texas, and Tucson, Arizona, until 1941 when he joined the Ohio Oil Company, later entering the service.

#2 in a series of advertisements discussing the position of processes in postwar refining

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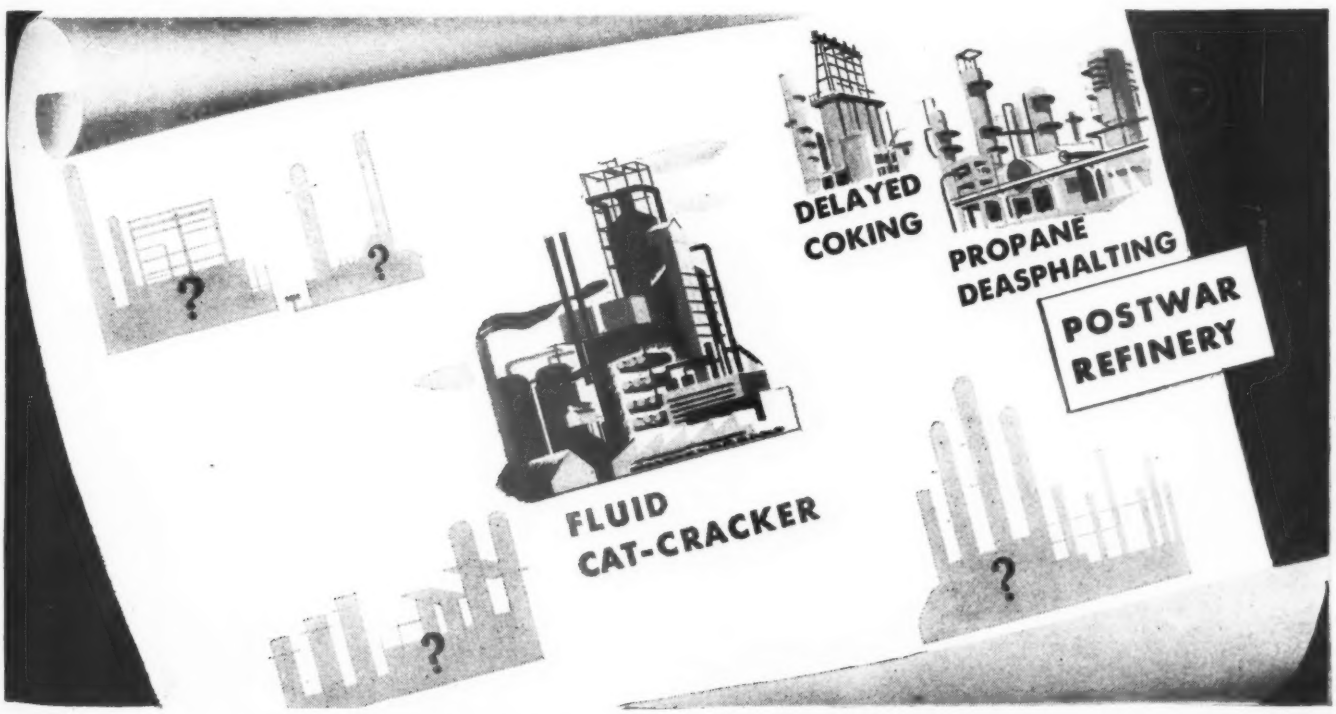


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two 12-hr. shifts. Some of the employes were slave laborers, but the majority were German. The average wage paid for skilled labor was one Reichmark an hour, equivalent in American money to about 25 cents. As the purchasing power of the mark was greater in proportion to the dollar, the skilled workman might be said to have earned about 75 cents an hour in terms of goods and services he could purchase.

● **Description of plant.** The brown coal is lignite, appears to be of Miocene Age, and lies in beds from 2 to 20 ft. in thickness. It is interspersed with lenses of silt, and overlain with about 50 ft. of Recent glacial deposits of unconsolidated sands and gravels. The coal pits are about one mile from the plant. The coal is mined in an open-pit manner, similar to that used in copper mines in Arizona and Utah. The overburden is stripped with giant endless buckets, which operate on rails circling the pit. As the pit becomes larger the rails are moved back in an ever-larger circle. The overburden is hauled to a dump via narrow-gage railroad. The transportation system is completely electrified. The ore, or coal, is a mealy, peaty substance, and is shoveled by chain buckets into railroad cars in the pit. After loading in the cars, the coal is hauled on an overhead track to the top of a four-story building containing bunkers.

From the bunkers, approximately one-half of the coal is carried by belt conveyers to the power plant, where it is dried, burned, and converted to electrical energy. The electric power thus obtained is used to operate the plant and to supply domestic and industrial electricity for Leipzig and a large surrounding area.

The rest of the coal deposited at the bunkers is carried by belt conveyers to the pulverizing plant, where it is pounded through sieves with revolving hammers. The screen used is about 1-in. mesh. The pulverized coal continues by belt-conveyer to the drying ovens, where the moisture content is reduced to 13 per cent. A lower moisture content would have insufficient cohesive qualities. The coal is then compressed into brickets, about 4 sq. in. in cross-section and 6 in. in length. The machines used to com-

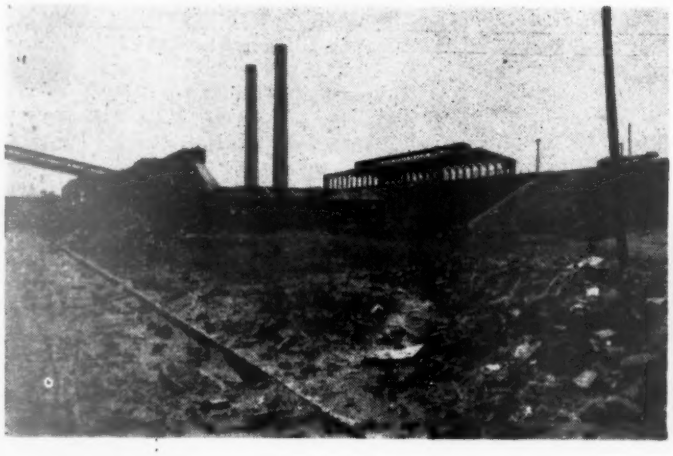
**Pulverizing plant. Conveyers to drying ovens at left and at rear.**

**Cooling towers, made of brick.**

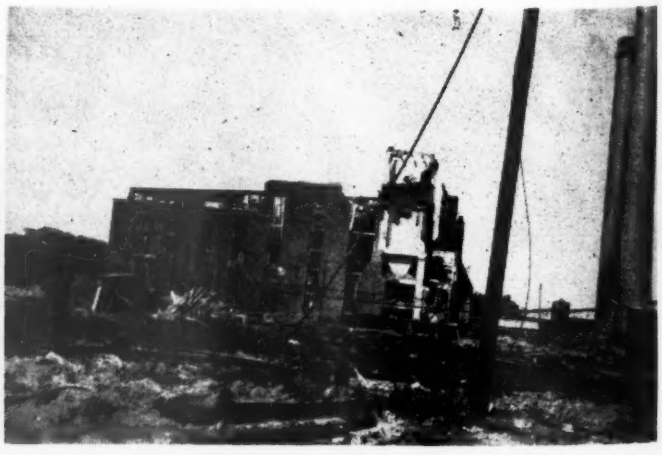
**Drying oven and bricket plant.**

**Absorption towers for removal of tar from gas.**

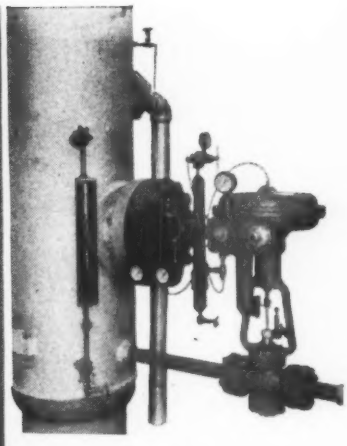
**Coal storage bunkers. Belt-conveyer at left carries coal to pulverizing plant. Power-house furnaces in background.**



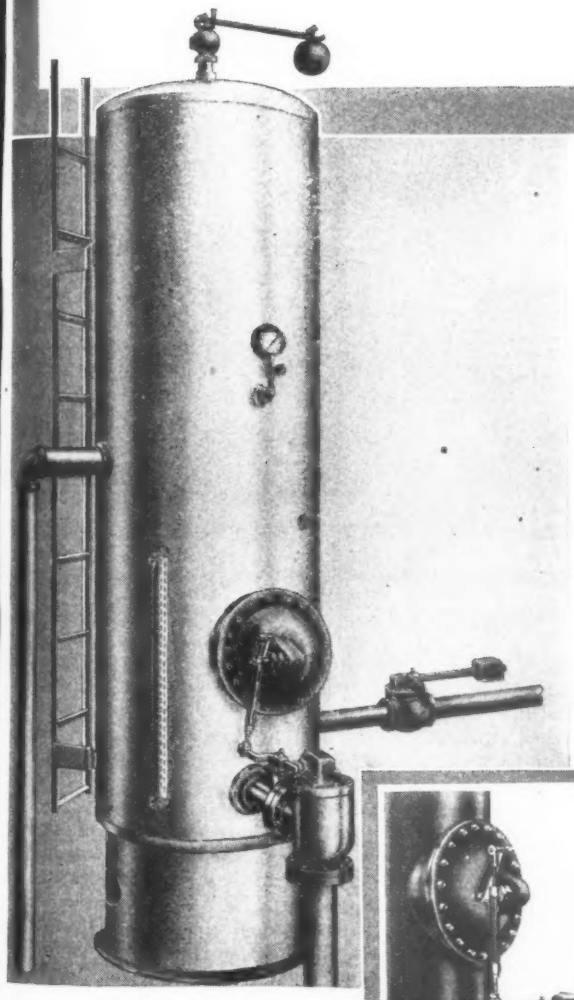
**Power plant, showing bomb damage.**



# NEW DEVELOPMENTS in oil and gas separation increase production



**NEW TORQUE TUBE** Level Controller now standard equipment on all Climax high pressure oil and gas separators.



CHANGING oil field conditions, increased production depths, higher working pressures and volumes, higher gravity crudes and distillates . . . all these have demanded corresponding improvement in separator design and control equipment.

In each phase of these developments, Climax Separators (formerly Hanlon-Waters) have set the pace with the most complete and finely engineered line of low and high pressure Separators—*and*—the precision controls and accessory equipment essential to obtain complete separation, and thus *maximum* production.

All Climax Separators for 250 to 3000 lb. pressures are API-ASME Code Construction with Pilot Operated Liquid Level Control. For 125 lb. working pressure, Climax Separators are available in both Standard and API-ASME Code Construction. Write for Bulletin No. 106.

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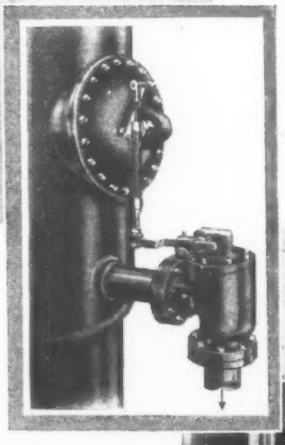
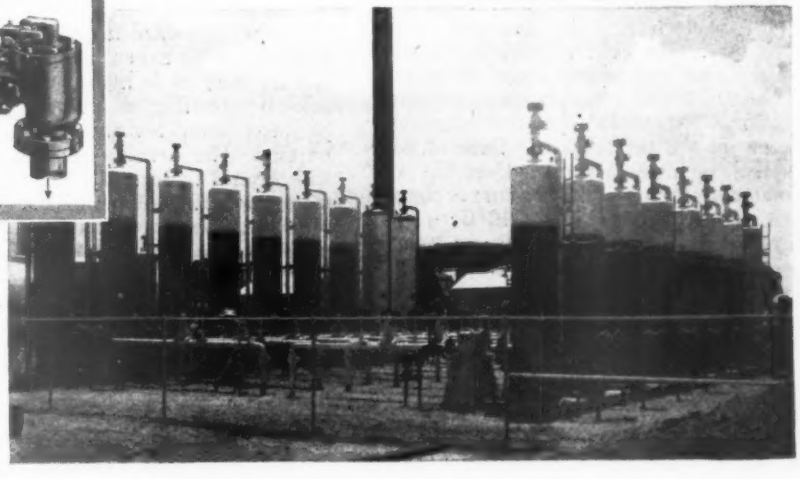


Above: 36" x 11' x 125 lb. Type CU-IS Separator with Direct Lever Connected Oil Valve and "High Power" Turnbuckle Linkage.

*Right:* Detail of Type H-575 "High Power" Linkage on Direct Connected 4" Type 820 Oil Valve with 14" Type 625 Float Flange.

*Below:* Battery of 36" x 16' Climax High Pressure Oil and Gas Separators on Metering Installation.



**IF YOU HAVE A SEPARATOR OR CONTROL PROBLEM** call on Climax engineers. Draw on their wide experience, on their readiness and willingness to help you. For informative bulletins or catalog, write Automatic Control Division (formerly Hanlon-Waters), Climax Industries, 15 N. Cincinnati St., Tulsa, Oklahoma.

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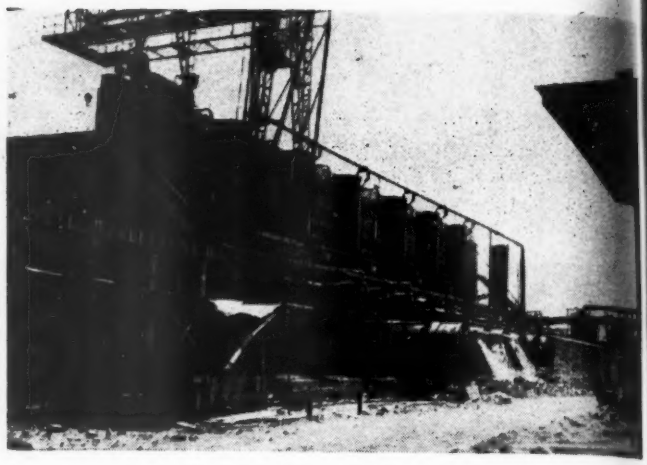
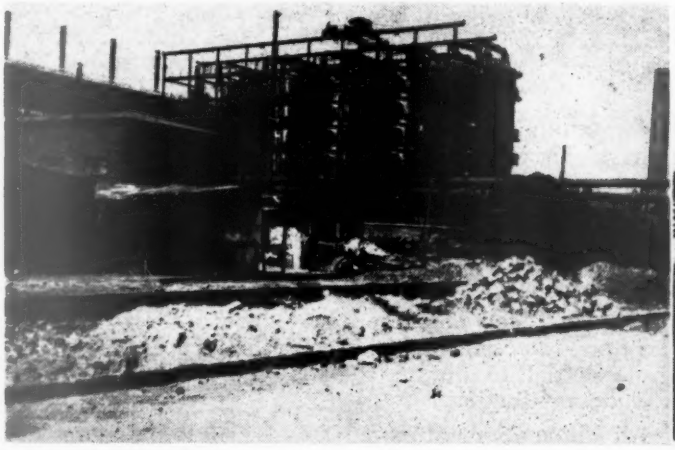
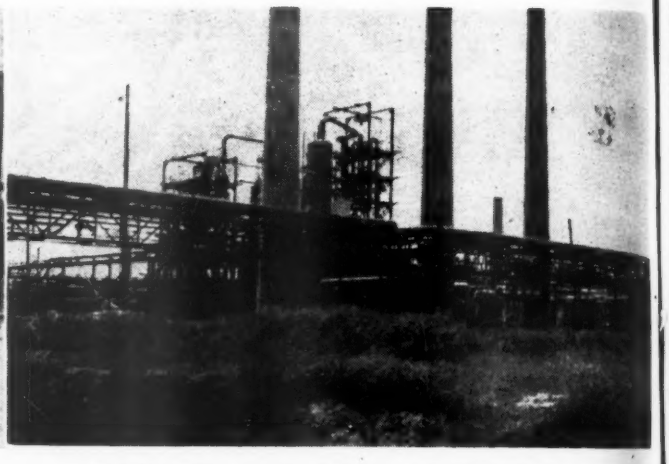
Coke furnaces. Captured French tank car in right foreground.



Part of paraffin plant.



Towers at hydrogenation plant, where teerantar is broken down.



Sulphur plant where $H_2S$ is removed from gas.

press the brickets look very much like an air compressor. A hopper drops a measured load in front of the piston, which compresses the brickets on the forward stroke.

The brickets are then carried to a bank of 30 large ovens, each with a capacity of 300 tons a day. These ovens operate on a continuous rather than a batch process, and the fuel requires about 24 hours to pass through the ovens. The brickets first become bone-dry and then they are burned in an absence of oxygen at 600°C. Three products are derived: Coke, gas, and tar or teerantar. The coke is burned for auxiliary heat and power. Some of the gas is cooled at 300 atmospheres of pressure from 280°C. to 25°C. at this stage. As some of the tar takes the form of colloidal particles suspended in the remainder of the gas, this mixture is charged with 50-60,000 volts at 110°C. to separate the two-phase state. This gas is then cooled at 300 atmospheres from 110°C. to 25°C. The cooling process condenses most of the liquid constituents of the gas, which are then added to the tar. All gas is then passed through an absorption tower, and in this manner the last 5 per cent of the benzine is removed from the gas.

The dry gas is then sent to the sulphur plant, where the $H_2S$ is removed in an alkaline solution in a vacuum. The production of sulphur is one of the most important byproducts of the plant. The dry sweet gas is then sold for domestic and industrial fuel.

The moisture collected from the ovens during the drying and burning is carried to the water plant, where phenols are removed. The water is then used in the cooling towers. An auxiliary water supply is from a reservoir nearby.

Two-thirds of the tar is piped to the Böhlen plant, a distance of about 3 miles. The other one-third is converted to end-products at the Espenhain plant. The tar is subjected to a hydrogenization and selective distillation process, the end products being benzine, diesel oil, and paraffin. The benzine is then blended with benzol to form a stable 75-octane motor fuel. The diesel oil is used directly for tractors and motor trucks. The paraffin is subjected to a cracking process, from which many of the common coal tar products are derived.

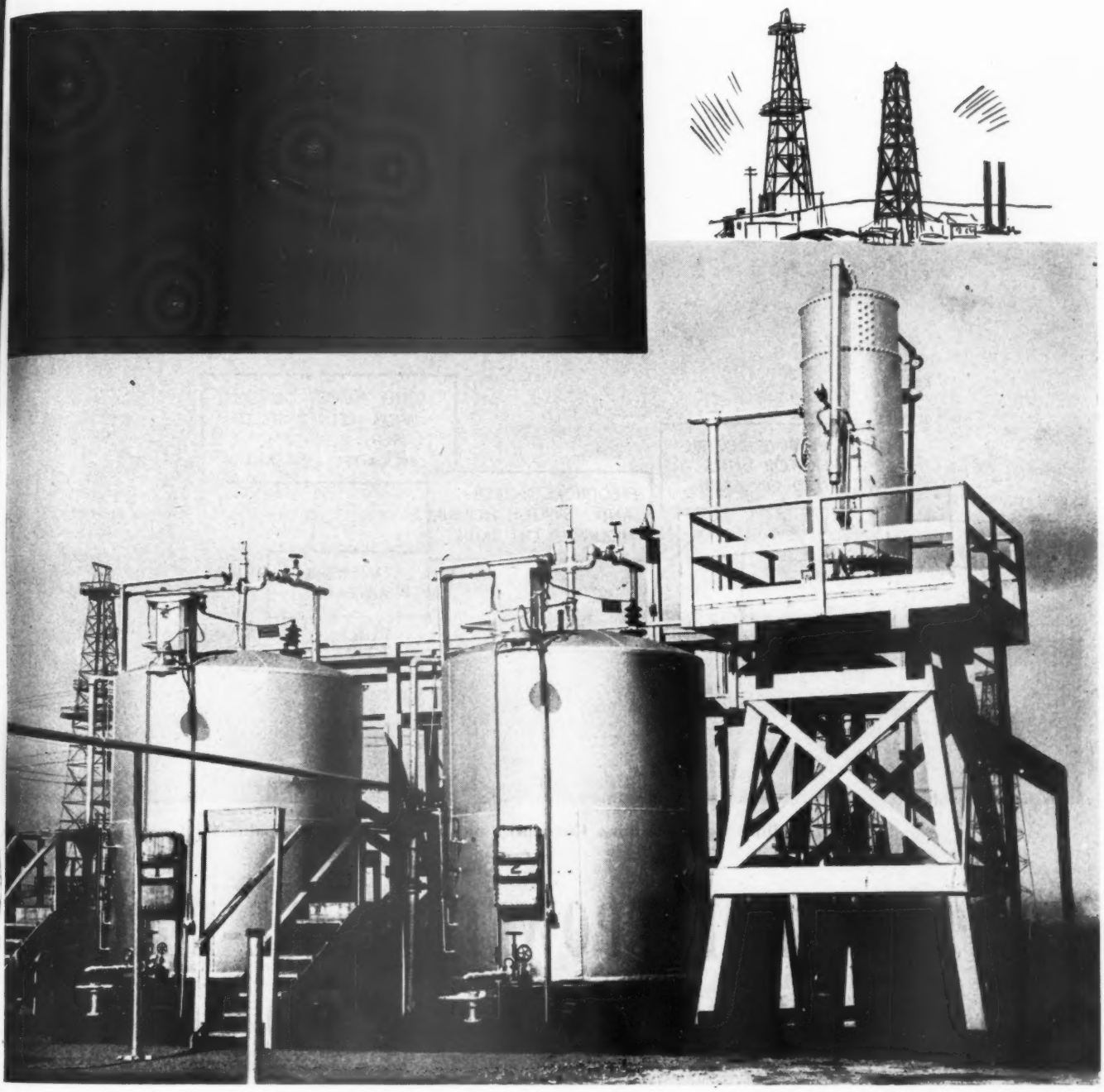
● **Summary of process.** Brown coal is burned without oxygen to form the following products: Benzine, diesel fuel, sulphur, sweet gas, and coal tar products such as dyes and plastics.

From an American point of view, the process seems to be expensive in terms of inefficient use of natural resources and man-power. When it is considered that this is the only source of liquid fuel in Germany, however, the reason for building the plants is apparent. It is likely that the byproducts helped a great deal in reducing the overall costs of production. The Germans had large supplies of cheap labor at their disposal, which also lowered costs. The beds of brown coal are very extensive, and the life of this particular plant was calculated to be 80 years of peak operation.

It is doubtful whether America will be reduced to producing gasoline from coal for many years to come. First we must exhaust our oil fields and then we can work our oil shale deposits. By the time these fuels are exhausted it is quite possible that gas turbines and rocket propulsion will require entirely new types of fuel.

● **Acknowledgments.** The writer is indebted to Lt. Col. H. W. Holmlin, Commanding Officer of the 269th Engineer Combat Battalion, 69th Infantry Division, for permission to visit the plant and to compose this article. Oberingeneur Carl Müller, Böhlen, conducted a tour through the plant and explained the process.

★★★



Dehydration is a constant problem wherever "wet" oil is encountered. When an operator is "sold" on some system for demulsification, he should become sold all over again when added efficiency points the way to further savings.

Take the case of an oil company operating in the Los Angeles Basin, when it was treating 15,000 barrels a month. Before modernization 8,015 barrels were treated by PETRECO. The remaining 6,985 barrels were treated by another method. The cost of this plan was $230.00 per month.

After modernization, *all* the oil was treated by the modern PETRECO automatic flowline dehydrators. The new cost of treating 15,000 barrels then was reduced from $230.00 to $102.50 per month.

The *monthly saving*, under PETRECO system, was $127.50.

*AND* the moderate outlay in making the modernization was refunded through materials salvaged in eliminating tankage, etc.

*AND* the completely automatic-control flowline plant does the demulsifying job with no worry and with the PETRECO field service at hand, day and night, to assure the best dehydration performance.

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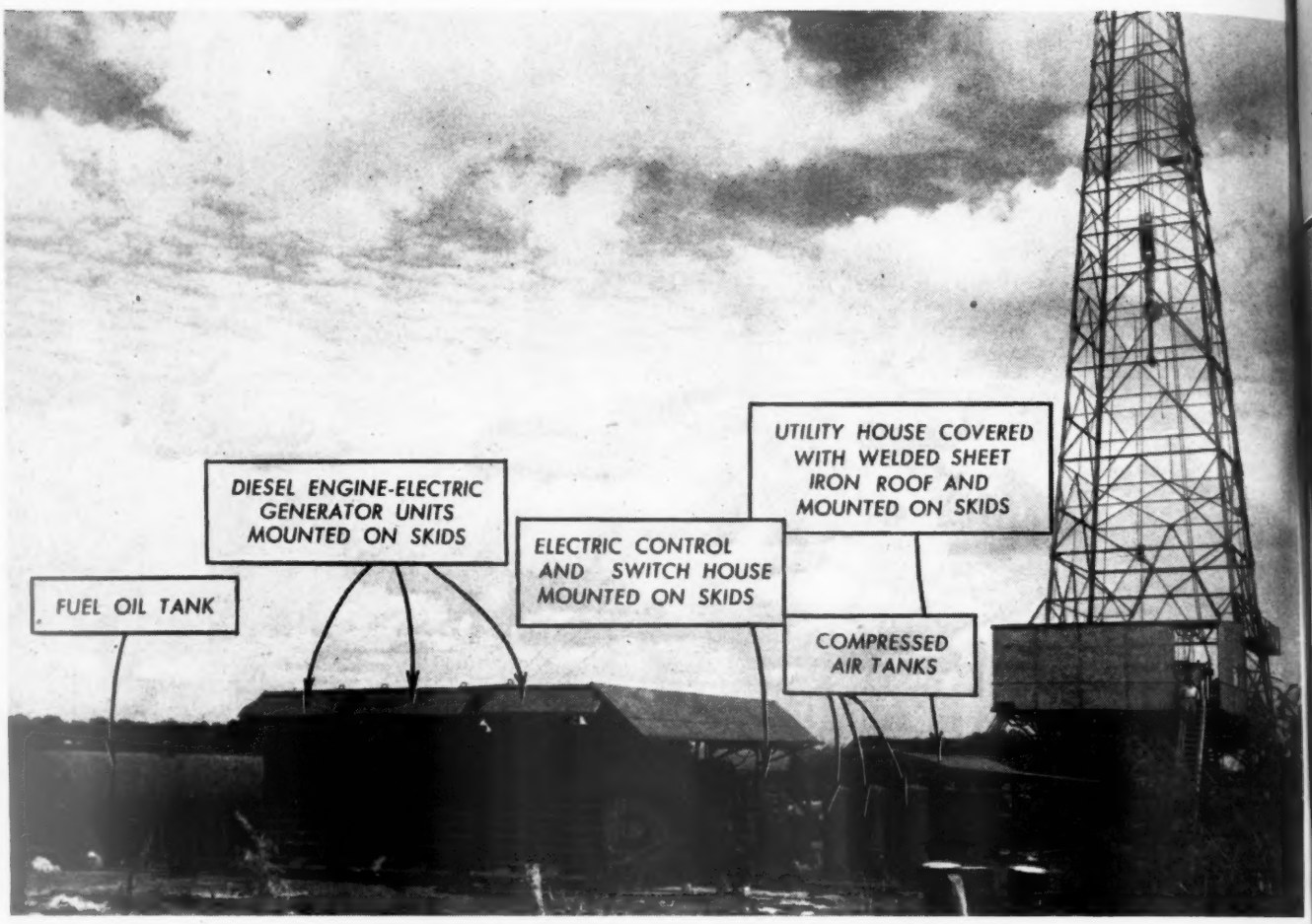
## DEHYDRATING • DESALTING


UTILITY HOUSE COVERED WITH WELDED SHEET IRON ROOF AND MOUNTED ON SKIDS
DIESEL ENGINE-ELECTRIC GENERATOR UNITS MOUNTED ON SKIDS
ELECTRIC CONTROL AND SWITCH HOUSE MOUNTED ON SKIDS
FUEL OIL TANK
COMPRESSED AIR TANKS

**Installing Rowan Drilling Company's new rig at Quintana's Spahn No. 1 near Gonzales, Texas.**

# NEW 2100-HORSEPOWER DIESEL-ELECTRIC DRILLING RIG IS COMPACT AND PORTABLE

By **K. MARSHALL FAGIN,** *Field Editor*

**EXCLUSIVE** One of the world's largest diesel-electric drilling rigs has just been assembled by the Rowan Drilling Company of Fort Worth, Texas, on its first location four miles northwest of the town of Gonzales in Gonzales County, Texas. It is scheduled to drill a 14,000 ft. wildcat test for Quintana Petroleum Corporation at this location, Spahn No. 1, several miles east of the Darst Creek field of south central Texas.

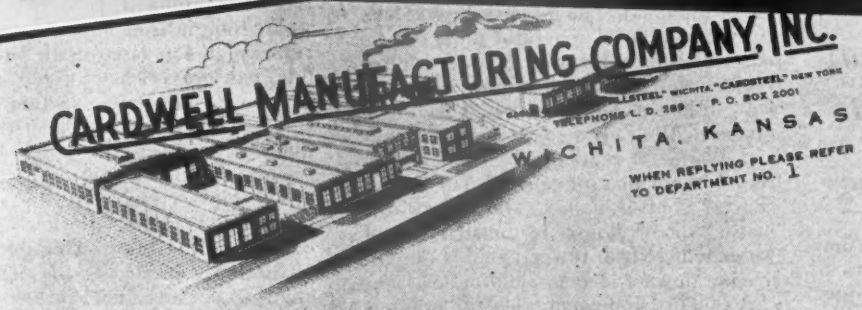
Three turbo-charged 8-cylinder diesel engines that can develop a total of more than 2100 b.hp. serve as prime movers. These are direct-connected through flexible couplings to the main 395-volt d-c. generators. Smaller auxiliary generators driven by V-belts from the main generator shafts are mounted on top of the main generators. These auxiliaries in turn are surmounted by 4-kw. variable voltage exciters. Each of the three diesel engines complete with its generator and instrument panel is mounted on heavy steel skids for easy handling by large winch trucks from one location to another. The three engine-generator units are situated side by side and covered with specially designed metal roofing units to form a compact engine generating house.

Electric current from the generators is fed through overhead cables to the central switch and control house for distribution to the hoisting, rotary table, mud pump, auxiliary motors, and lighting system. The switch and control house is likewise mounted on skids for easy transfer from location to location.

A utility house is situated beside the engine-generator house. This contains a diesel utility engine direct-connected to a 30-kw. 125-volt 1200-r.p.m. constant voltage auxiliary generator; an arc welding current transformer, and a two-stage air compressor driven directly by a 15-hp. electric motor. The compressed air is piped through the utility house wall into three 72-gal. storage tanks mounted on the outside. The diesel utility engine is started by a 6-cell storage battery.

● **Electric power cables overhead.** Heavily insulated multi-conductor electric cables carry the electricity from the switch and control house to the mud pumps, hoisting motor, and rotary table motor. These cables are strung overhead and supported at each end by short lengths of chain that have special rubber-lined clamps to hold and protect the cable insulation from damage. The cen-

# TEN YEARS AGO THE AVERAGE PARTS BILL ON A "CARDWELL" RIG WAS $122.64 PER YEAR....



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The cost of repair parts represents less than 20% of the total repair bill. Downtime, traveling expense and labor account for the other 80%. We know the real value of dependable wearing parts and use the most scientific methods to produce them.

Behind every "Cardwell" rig is an efficient organization of parts stock stores. Nine strategically located stores in the United States, and five foreign stores planned for postwar, will also effect a reduction in downtime and operating costs.

A full line of improved drilling rigs and servicing hoists is now available on reasonable delivery schedules. Write for complete information and prices.

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"CARDWELL" RIGS ARE STRONGER, WEAR LONGER AND WEIGH LESS

***This powerful rig with its driveway, pipe racks and full-size slush pits needs less than 2.7 acres of ground.***

ter of the main span of cables (from the switch house to the rear of the derrick floor) is supported by three welded pipe poles. The cables carrying electricity for the mud pump motors are dropped from these poles to the motor connections. All cable connections are made by railway-type plugs and receptacles.

● **Mud-pump-motor units.** Two of the mud pumps are large triplex double-acting 65 to 70-r.p.m. 800 gal. per min. pumps driven by 400-hp. 900-r.p.m. electric motors through V-belts and reduction gears. Each mud pump with its motor is mounted as a unit on a heavy I-beam skid-type base. The mud pump motors are cooled by top-mounted rotary blowers driven by direct-connected 3-hp. 1750-r.p.m. motors.

A third mud pump of new design has been installed for field trials in drilling this well. It is a 10-cylinder plunger-type pump direct-driven through a flexible coupling by a 600-hp. 500-r.p.m. electric motor.

● **Hoisting motor-control rack unitized.** The drawworks is operated by an 800-hp. 600-r.p.m. electric motor. This motor is mounted on the same skids that carry the derrick floor control rack. The three main diesel-generator units can be controlled from this derrick floor control rack as well as from the main switch and control house. This permits all members of the drilling crew to work on the derrick floor and regulate the electric current without making special trips to the central control house. The drawworks motor-control house is constructed of welded sheet iron in sections for ease in tearing down and reassembling.

A 300-hp. 750-r.p.m. electric motor is direct-connected with a flexible coupling to the rotary table. This motor is mounted as a unit with the rotary table on a heavy steel base.

● **Doghouses built in substructure.** The derrick floor and motor-control house is situated on a 14-ft. 1,000,000-lb. dead load substructure. Two specially designed welded sheet iron doghouses are built into the lower substructure under the motor-control house. One of these is used for a tool house. The other serves as a change house for the crew. Access to the derrick is provided by a set of safety-type steel stairways on each side the derrick.

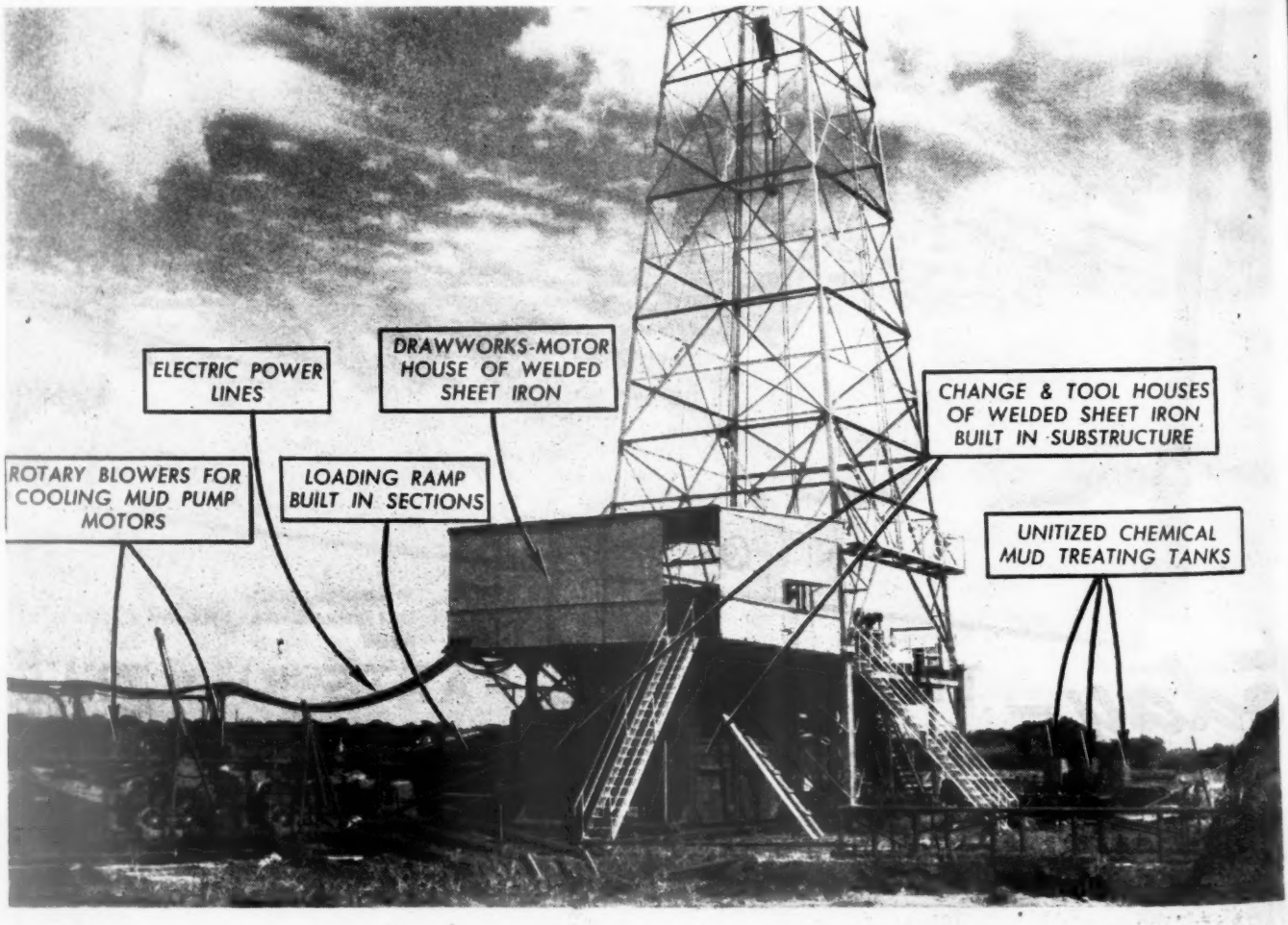
A regular 136-ft. 800,000-lb. dead load API steel derrick is being used on this rig. The drill pipe and casing racks are supported by welded angle iron bridge-type frames that are simple to bolt up and level; easy also to move from location to location.

● **New loading ramp design.** A specially-designed loading ramp is part of the rig equipment. It is constructed of welded angle iron in four sections. The runway on top is covered with 4-in. by 6-in. oak cross-ties set about 2-in. apart to provide adequate traction for truck tires. The sides of the runway are guarded to keep the truck wheels or equipment on the ramp.

The top section of the upper part of the ramp is removed when trucks are backed up the ramp. This puts the bed of the truck level with the derrick floor and thus permits easier transfer of heavy items such as the rotary table, which cannot be skidded up the ramp.

The outside section of the lower part of the ramp may be disconnected and pulled off the wide turn-around section of the plank driveway, which is laid between the well and the pipe racks. This increases the usefulness of the turn-around section of the driveway. It also permits considerable reduction in the amount of lumber required to build the driveway.

**Mud pumps driven by electric motors are mounted on skids with welded pipe supports hinged on the slush-pit side of the skids for regulating the level of the mud pump intake pipe.**


ELECTRIC POWER LINES
DRAWWORKS-MOTOR HOUSE OF WELDED SHEET IRON
CHANGE & TOOL HOUSES OF WELDED SHEET IRON BUILT IN SUBSTRUCTURE
ROTARY BLOWERS FOR COOLING MUD PUMP MOTORS
LOADING RAMP BUILT IN SECTIONS
UNITIZED CHEMICAL MUD TREATING TANKS

# NO FIREWALL
# NO FORCED VENTILATION
# NO EXTERNAL COOLING

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These Westinghouse high-capacity, dual-ventilated, explosion-resisting motors for pipeline and refinery service were the *first* large motors for hazardous-location service ever built in sizes 500 hp and above, without the use of forced ventilation or external cooling equipment.

Instead, they employ the long-proved, dual-ventilated, integral frame . . an original Westinghouse development . . . since, *accepted as a standard* for the industry. With this construction you get an entirely self-contained unit; no firewalls, no ventilating ducts or other equipment are needed. And you get ample power, *economically*. They're available in ratings up to 1000 hp, 3600 rpm.

It took more than *electrical ability* to design and build these motors—it also took *actual petroleum experience* —years of it. The fact that more Westinghouse motors of this type are in use today than those of all other manufacturers combined, is definite proof of their superiority. Your nearest Westinghouse office will be glad to give you detailed information. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-94683

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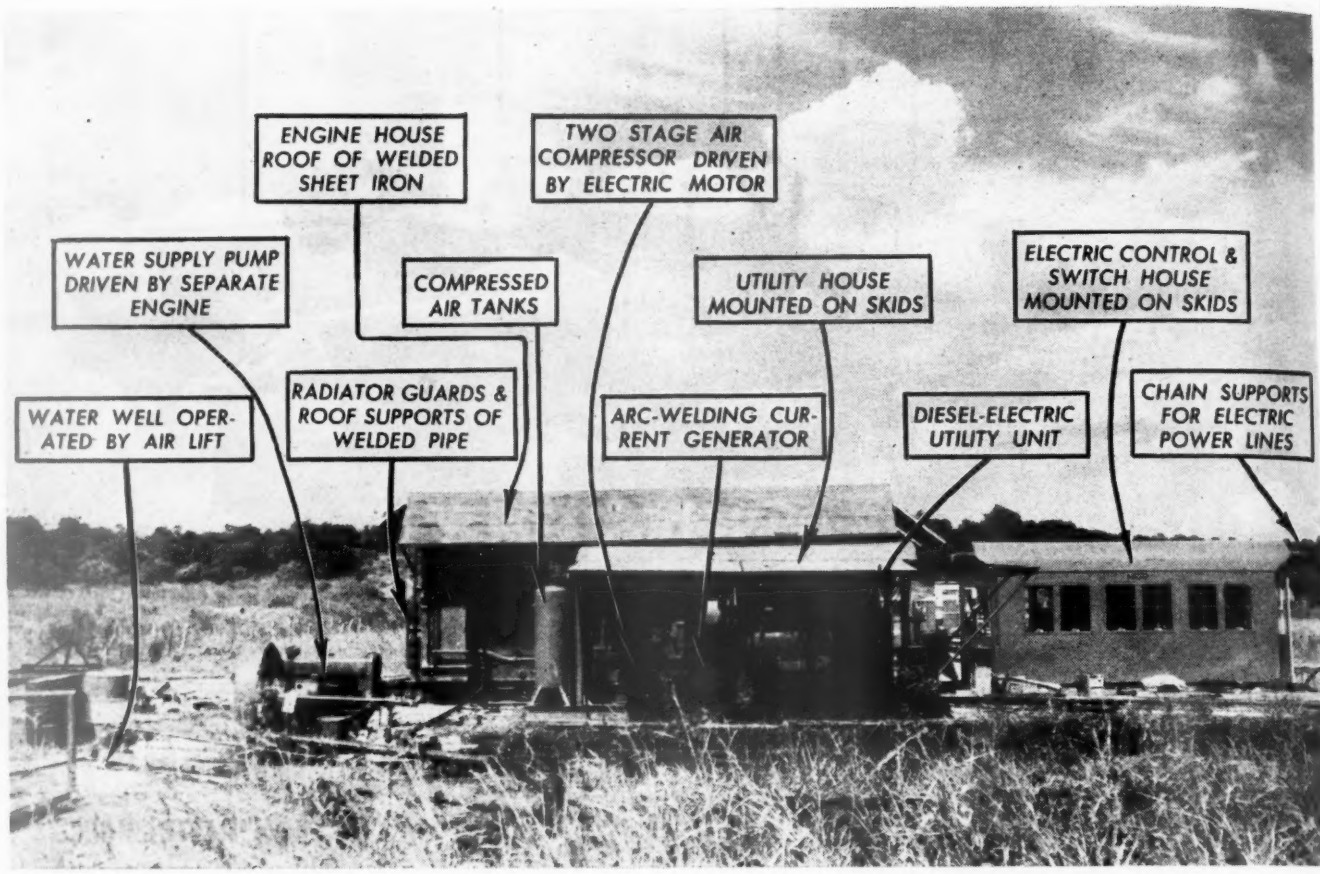
**ELECTRICAL EQUIPMENT FOR THE PETROLEUM INDUSTRY**


ENGINE HOUSE ROOF OF WELDED SHEET IRON
TWO STAGE AIR COMPRESSOR DRIVEN BY ELECTRIC MOTOR
WATER SUPPLY PUMP DRIVEN BY SEPARATE ENGINE
COMPRESSED AIR TANKS
UTILITY HOUSE MOUNTED ON SKIDS
ELECTRIC CONTROL & SWITCH HOUSE MOUNTED ON SKIDS
WATER WELL OPERATED BY AIR LIFT
RADIATOR GUARDS & ROOF SUPPORTS OF WELDED PIPE
ARC-WELDING CURRENT GENERATOR
DIESEL-ELECTRIC UTILITY UNIT
CHAIN SUPPORTS FOR ELECTRIC POWER LINES

**The water supply pump driven by a separate engine has now been replaced by a new 4-in. by 6-in. duplex driven by an electric motor and mounted in the utility house. Note the way the sides of this house are hinged and supported by pipes to provide ventilation, shade, and shelter for the equipment.**

● **Mud treating tanks unitized.** Three welded iron chemical treating tanks with feed control are mounted on the sheet-iron possum belly trough. This unit is easy to move into its position between the well and the mud pits. A twin table shale shaker is used to clean the drilling mud after it flows from the well and through the possum belly.

At the present site a 500 ft. water well cased-off with 4-in. pipe is producing an ample supply of water by jetting it with air from the utility house compressor. The water flows from the well into water supply pits near the utility house. A 4-in. by 6-in. duplex water pump mounted in the auxiliary house and driven by a 10-hp. 1200 r.p.m. electric motor supplies water for washdown, radiator make-up, and other utility purposes.

A small independently operated duplex water pump is mounted on a 30-gal. high pressure water tank to operate the blowout preventers in case the regular supply of water should fail.

● **Main diesel engines turbo-charged.** The three main prime movers are identical 8-cylinder 9-in. by 10½-in. 900-r.p.m. diesel engines with exhaust turbo-chargers and rated at 700-hp. each including the power needed to operate the fan and built-in water pump. The engines are started with compressed air from the utility house air tanks. Protection is provided against excessive water temperature or low oil pressure by thermostatic and pressure controls that function automatically.

The engines are equipped with governors that automatically synchronize and govern the engines under variable loads. Intake air is cleaned by a large oil bath air filter, and the oil pressure is automatically maintained by special pumps and controls. The lubricating oil is not only continuously filtered as the engines run, but the oil is cooled by circulation through a special oil section in the radiator.

● **Main generators are direct-connected.** Two of the main generators are 400-kw. variable voltage 1010-amp. 900-r.p.m. machines. The third main generator is the same kind but produces only 300-kw. of power. These are direct-connected to the diesel engines through flexible couplings. A fourth 135-kw. variable voltage 1200-r.p.m. generator is mounted on top of the 300-kw. generator and is driven from the main shaft by V-belts.

Two 35-kw. 125-v. 1750-r.p.m. constant voltage auxiliary generators are mounted on top of the 400-kw. main generators and driven by V-belts from the main shaft. A 4-kw. variable voltage exciter is mounted on top of each of these 35-kw. auxiliary generators. The exciters are likewise driven by V-belts from the main shaft. Two other 4-kw. exciters are mounted on the engine bed plates and driven by V-belts from the main shaft to provide excitation for the 300-kw. and 135-kw. generators on the third main unit.

Excitation of the main generators by these 4-kw. variable voltage exciters has reduced the amount of resistance framework formerly required when excitation of the generator field was provided from a constant voltage source. The need for resistance in series with the generator field has thus been eliminated.

● **Controls provide independent actions.** By means of the main and auxiliary generator control equipment in the main switch house the diesel-electric power can be regulated to perform all or any of four different functions, namely, operate the rotary table, pull the drill pipe, circulate drilling mud, or mix mud. The inherent flexibility provided by diesel-electric power is utilized to full advantage in this new rig.

In addition to the special pump to operate the blowout preventers, many other precautions have been taken to provide safety, better working conditions, lower maintenance costs, and unitization of equipment for both compact rig arrangement and portability.

The entire drilling rig including pits and pipe racks, for example, can be easily arranged in a clearing as small as 2.7 acres, or 120,000 sq. ft., or an area 400 ft. long and 300 ft. wide. Time and money may be saved by taking advantage of the compactibility of this rig. The quiet, controlled, and smooth operation of the heavy machinery on this large rig should result in lower maintenance costs and longer life of the equipment.

★★★

# HEAVY MUD

A good weighting agent adds only weight to the drilling mud. Its addition should bring about only slight change in the other drilling mud properties. BAROID, the pioneer weight material, provides high weight with low increase in solids and only slight increase in viscosity.

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The universal use of BAROID proves the effectiveness of BAROID-weighted muds in preventing blowouts by confining gas, water and oil to their respective formations, and in preventing stuck tools and loss of hole by checking caving.

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# NEW METER IDENTIFICATION CARD PROTECTED

By **O. C. IRVINE,** United Gas Pipe Line Company

**EXCLUSIVE** THE measurement department of United Gas Pipe Line Company's Shreveport district has developed a new meter station identification card to replace the old style cards that, although the information they carry is of utmost importance to accurate measurement, have heretofore been subjected to the ravages of dust, rodents, dirt daubers, and unfavorable weather conditions.

The old cards, either hung from the meter manifold by means of a metal holder or mounted on a wall of the meter building, become illegible and of negligible benefit to chart changers and meter repairman after about one year of usage. This results in a more or less routine duty of retyping meter cards once a year.

When the department was faced with this annual duty recently, considerable thought and discussion lead to the adoption of the new card, trimmed in size by more than half by utilizing both front and back faces, and protected by inserting it in a 2½-in. by 3¾-in. celluloid case.

The reduced size was accomplished without sacrifice of any information formerly carried by cutting the original form in half, trimming margins, and placing orifice plate data on the reverse side of meter information. The card, inside its celluloid cover, is mounted on the inside of the meter case door by use of a No. 5 bolt screw, ⅛-in. in length, and a clip made from a 1¾-in. section of discarded clock spring.

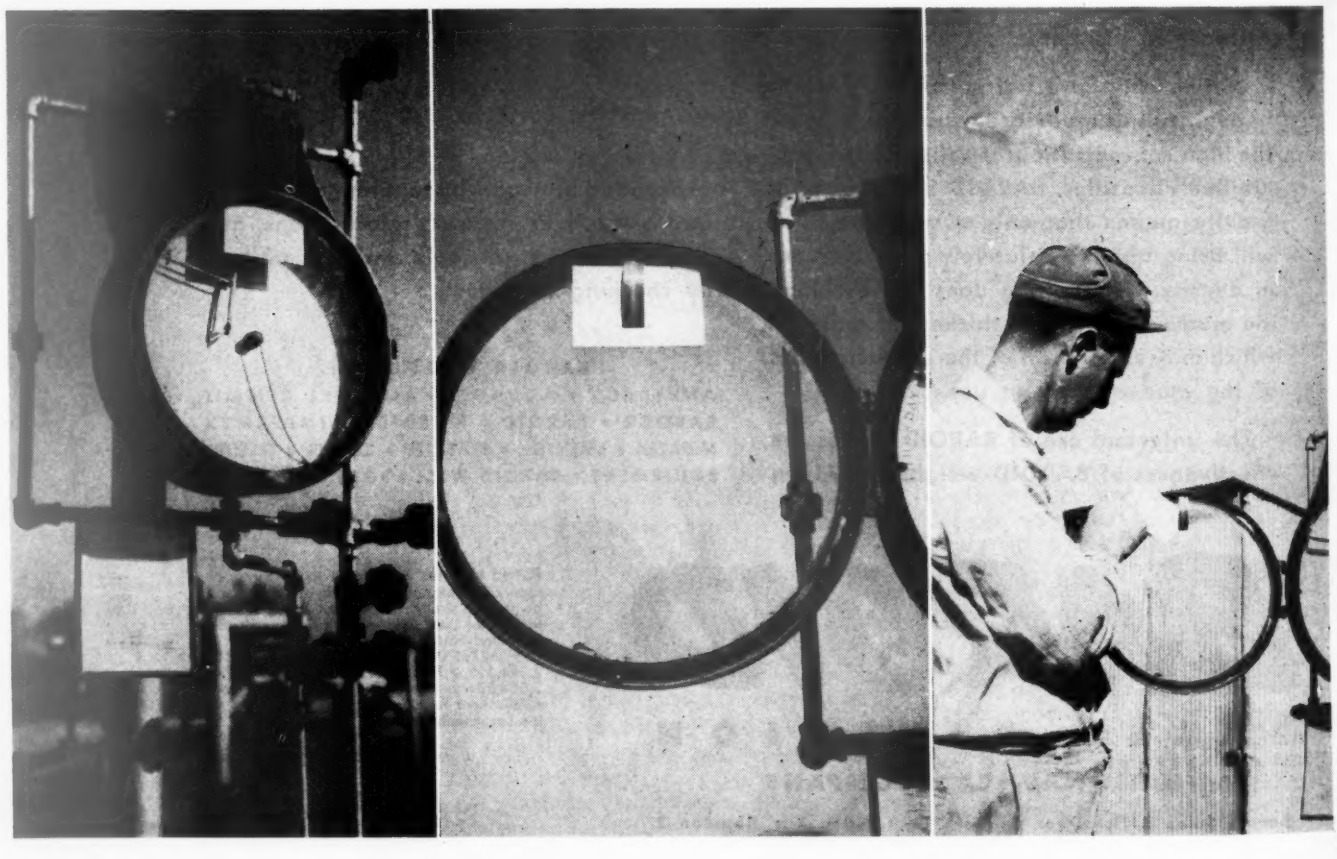
Spring tension of the clip holds the card firmly against the glass door with the full face of the card visible in a position that does not obstruct view of the meter pens. When the meter door is open the back of the card is displayed for view. Inside the meter case the card is doubly protected from dust and weather, and being mounted at the top of the case is out of range of ink that might be spilled from overfilled pens.

The celluloid case opens at the back making the reverse portion of the card easily accessible for notations in connection with orifice plate changes. An advantage is provided in having the card in two sections, placed back to back in the holder. In the event that plate changes exceed the number of lines provided, this section of the card can be replaced without having to retype the entire card.

Sponsors of the new meter identification card feel that this method of display, besides presenting a more attractive appearance of meter installations, will postpone indefinitely the yearly task of retyping entire sets of cards.

At left in the accompanying pictures, both the old and the new type cards are shown by way of comparison. At center is a rear view of the new card that illustrates the method of mounting it. At right, a meter inspector demonstrates the ease with which a new style card is inserted under the clip prepared for it. Photographs are by J. M. Steele, Shreveport district measurement superintendent. ★★★

**First, the new and old types of meter cards are shown; second, the meter is open and the new card is shown from the back held by a spring tension clip, and, third, an inspector demonstrates how the card is mounted.**



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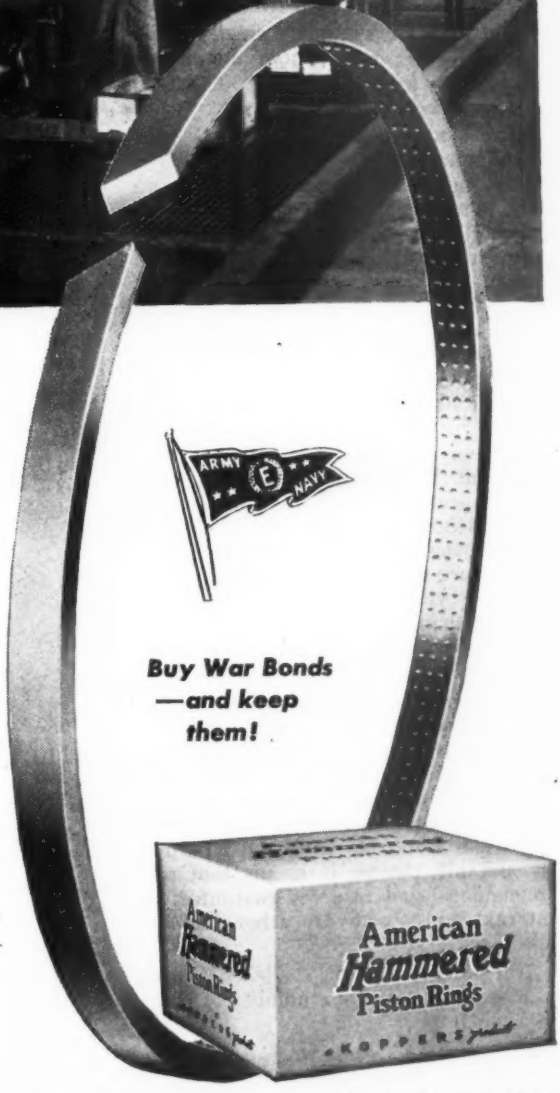



**FOR TOMORROW—*Count on those who are doing the tough job today***

# PRODUCTION OF SYNTHETIC LIQUID FUEL FROM NATURAL GAS*

By V. I. KOMAREWSKY†

THE synthesis of hydrocarbons from carbon monoxide and hydrogen mixtures is a problem of primary importance in our national war and peace economy. The versatility of the process, the variety of the products and the mild operating conditions are the attractive features of this synthesis. It is in the interest of gas and petroleum industries to study, develop, and improve the methods of catalytic conversion of carbon monoxide-hydrogen mixtures to hydrocarbons.

The gas industry can find in this method:

a. A means for upgrading the gas.
b. A new use for gas.
c. An enrichment of water gas independent of petroleum.

The petroleum industry creates a new potential supply of liquid motor fuel equal to at least one-half of known petroleum resources.

The synthesis of hydrocarbons from carbon monoxide-hydrogen mixtures is based on the catalytic reduction of carbon monoxide by hydrogen, known as Fischer-Tropsch reaction, and proceeds according to the following equation:

$$X\ (CO + 2H_2) \rightarrow (CH_2)_x + XH_2O \quad (1)$$

In the above equation X depends upon the conditions of the reaction and the entire series of hydrocarbons from methane to paraffin wax is usually received.

Thus 1000 cu. ft. of synthesis gas (33.3 per cent carbon monoxide; 66.7 per cent hydrogen) theoretically will give approximately 2 gal. (12.3 lb.) of hydrocarbon material. Actually, however, incomplete reaction and gas formation reduce the yield of product. In practice, the yield of hydrocarbons, other than methane, ethane and ethylene, is 1.4 to 1.5 gal. (9.5 lb.) per 1000 cu. ft. of synthesis gas.

The so-called synthesis gas is a mixture of one part carbon monoxide and two parts hydrogen by volume. The flexible nature of the Fischer-Tropsch process is evidenced by the fact that any carbonaceous material can be transformed to carbon monoxide hydrogen mixtures by suitable means. It means that our tremendous coal reserves guarantee an internal source of hydrocarbon fuel for many centuries.

Natural gas can be easily converted to a synthesis gas by a number of reactions such as:

*Presented before War Production Conference, Chicago, Illinois, March 29, 1945.

†Mr. Komarewsky is professor of chemistry, Illinois Institute of Technology and consultant of Institute of Gas Technology.

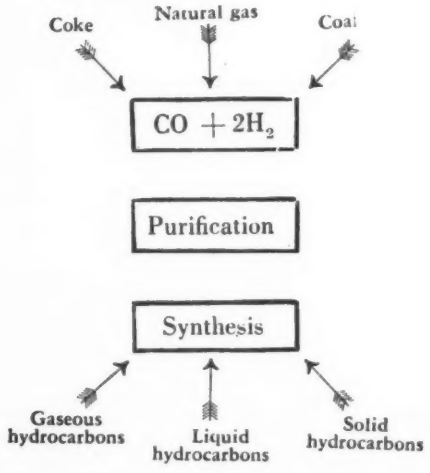
***Catalytic conversion of carbon monoxide-hydrogen mixtures to hydrocarbons of great importance to gas and petroleum industries.***

$$3\ CH_4 + 2H_2O + CO_2 \rightarrow 4CO + 8H_2 \quad (2)$$

$$CH_4 + \tfrac{1}{2}\ O_2 \rightarrow CO + 2H_2 \quad (3)$$

The proved reserves of natural gas in this country has been estimated at 100 trillion cu. ft. If an 85-90 per cent conversion to synthesis gas is obtained, the total natural gas reserves could be converted into about 9 billion bbl. of high-grade synthetic oil by present methods. Since the proved crude oil reserve in the United States is about 20 billion bbl., it is evident that the conversion of natural gas to synthetic oil is an important consideration.

The basis steps in the production of hydrocarbons from carbon monoxide and hydrogen can be represented by the following scheme:




The purification of carbon monoxide-hydrogen mixtures and the preparation for the synthesis requires special attention.

First, there is the requirement that the synthesis gas be composed of hydrogen and carbon monoxide in the ratio of 2:1 for the industrially developed cobalt catalysts. This is occasioned by the nature of the reaction (equation 1). Processes have been developed which can produce synthesis gas from a wide variety of materials. The production of synthesis gas from natural gas by means of steam gives a ratio of 3:1, i.e.,

$$CH_4 + H_2O \rightarrow CO + 3H_2 \quad (4)$$

The use of carbon dioxide (equation 2) or oxygen (equation 3) produces gases of the proper composition.

The second requirement, which has proved a considerable obstacle to the progress of the synthesis is the necessity of an absolute absence of sulphur in the synthesis gas. The upper limit of sulphur concentration that can be tolerated by the active catalyst is approximately 0.1 grain per 100 cu. ft.

The problem can be solved in one of two ways: (a) by means of desulphurization or (b) by developing a sulphur-resistant catalyst. The first method has been used almost exclusively since a sufficiently active sulphur-resistant catalyst has not yet been developed.

The products of synthesis are gaseous, liquid and solid hydrocarbons. The properties and specific composition of each depends entirely upon the catalyst and other reaction variables, such as pressure, temperature, carbon monoxide-hy-

**TABLE 1**
**Composition of Kogasin.**

| | Per cent by weight | Olefins, vol. per cent |
|---|---|---|
| $C_3$- and $C_4$- hydrocarbons | 8 | 55 |
| Gasoline (to 302°F.) | 46 | 45 |
| Naphtha (302-392°F.) | 14 | 25 |
| Diesel oil | 22 | 10 |
| Paraffin wax from oil* | 7 | .. |
| Paraffin wax from catalyst* | 3 | .. |

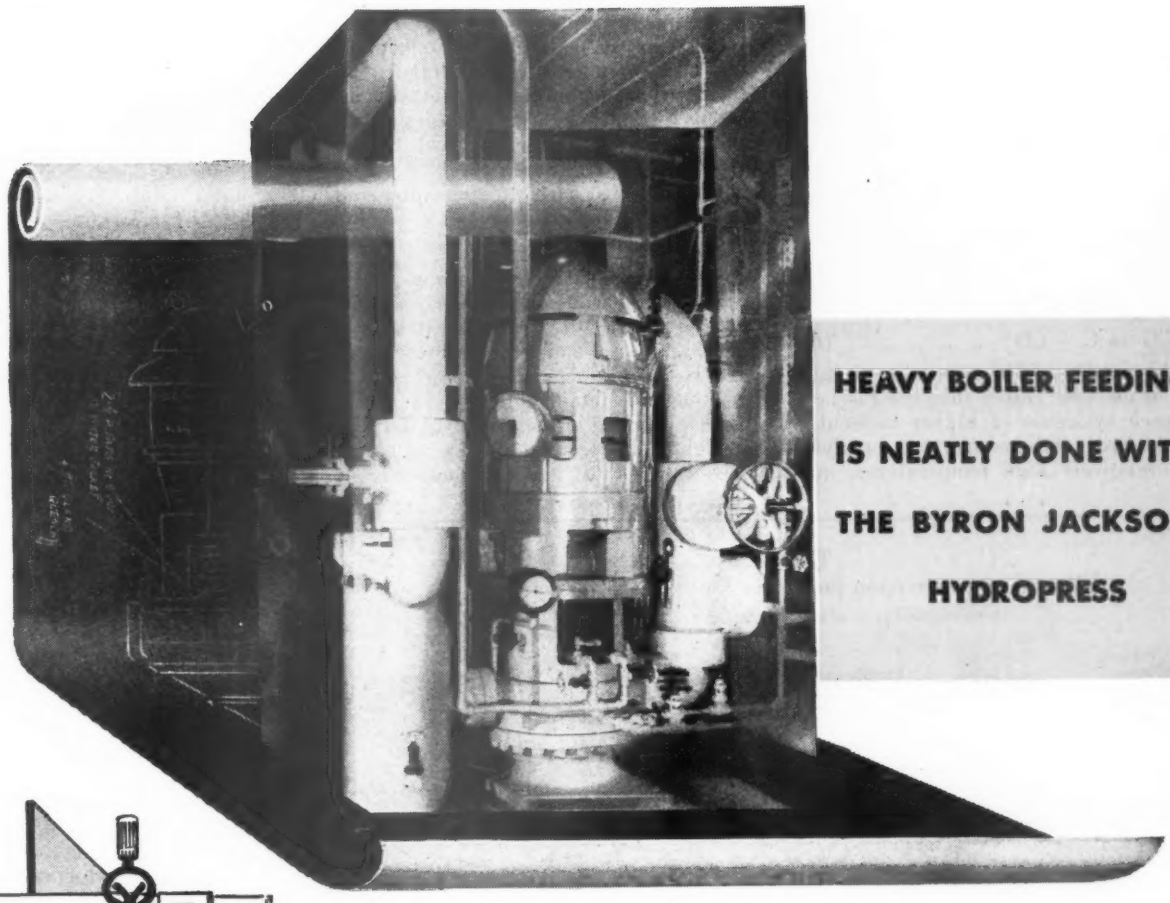
*Melting point, 122°F.
*Melting point, 194°F.

**TABLE 2**
**Processing of Kogasin to produce gasoline.**

| | Yield*, vol. per cent |
|---|---|
| Light gasoline* | 29.1 |
| Reformed gasoline from naphtha† | 26.8 |
| Cracked gasoline from bottoms | 22.6 |
| Polymer gasoline | 5.8 |
| | 84.3 |

Octane number of blend of all gasolines, 66.
*Based on Kogasin oil charged, original octane number was 20.
*Octane number of 97-241°F. fraction was 68.
†Octane number of the 219-523°F. fraction before reforming was 4.

# IN 2 BY 5 BY 8



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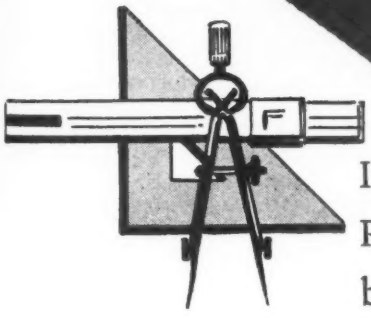

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drogen ratio, and the time of contacting of synthesis gas with the catalyst.

The following are the most important modifications of hydrocarbon synthesis from carbon monoxide-hydrogen mixtures.

● **Sabatier synthesis.** The conversion of carbon monoxide and hydrogen to methane was first accomplished by Sabatier and Senderens using nickel as catalyst:

$$CO + 3H_2 \rightarrow CH_4 + H_2O \quad . \quad . \quad (5)$$

This reaction could conceivably produce synthetic natural gas from coal. However, two major technical difficulties are encountered, namely, poisoning by sulphur and poisoning by carbon deposition. The latter is caused by a blanketing of the active catalyst centers according to the following reaction:

$$2CO \rightarrow C + CO_2 \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The conditions favoring the production of methane rather than the Fischer-Tropsch synthesis of higher molecular weight hydrocarbons are: (a) catalyst, (b) relatively high temperatures, and (c) high proportion of hydrogen in the reacting gases. Nickel and iron catalysts are active at atmospheric pressure. The temperature required is about 570°F. for nickel catalysts. The ratio of hydrogen to carbon monoxide theoretically should be three (equation 5).

It is of passing interest that carbon dioxide may be hydrogenated to methane at 570°F. over a pure iron catalyst. Ruthenium powder of ruthenium-thoria-asbestos also may be used for the production of methane from $CO_2$ at 212°F. However, after the initial step, which is conversion to carbon monoxide and water vapor, the reduction proceeds according to equation (5).

● **Kogasin synthesis at atmospheric pressure.** By using cobalt-thoria-Kiesulguhr (100:18:100) catalyst at atmospheric pressure and temperature of 375-390°F. the product of the following composition was obtained (Table 1).

The product is composed of largely straight-chain paraffin and olefin hydrocarbons with only minor amounts of aromatics, naphthenes or oxygen-containing compounds.

Table 1 presents data for the various fractions of the primary product when a cobalt catalyst was used. The gasoline boiling up to 392°F. constitutes 60 per cent of the total product. Because of the straight-chain nature of the hydrocarbons in the product, the gasoline fractions have low octane numbers. Thus the octane number of the gasoline boiling in the aviation range (up to 302°F.) was only 55.

The octane number of the gasoline and the total yield of gasoline can be increased by reforming and cracking in conventional petroleum plant equipment. Thus, Egloff, Nelson, and Morrell, by means of thermal reforming and cracking and catalytic polymerization of the cracking gases, received 84.3 per cent of 66-octane gasoline from a Kogasin oil that, originally, had an octane number of 20 (Table 2).

Diesel oil may be separated from the total Kogasin oil by simple distillation. It has a high cetane number due to the straight-chain character of the hydrocarbons contained in this fraction and is suitable for mixing with low-cetane-number oils.

The paraffin wax produced in the synthesis is similar to the product received from petroleum and can be put to the same uses. Since 1936 catalytic oxidation of the synthetic wax has been used for the production of synthetic fatty acids. The product consists almost entirely of saturated normal fatty acids of both odd and even carbon number, which are used for the manufacture of soap, cooking fats and artificial butter.

The Kogasin product as such does not contain any lubricating oils. To meet this need, methods have been developed in Fischer's laboratory to produce synthetic lubricating oils. Among those which have been reported are: (1) Polymerization of fractions rich in olefins with aluminum chloride; (2) chlorination of Kogasin fraction and polymerization without the addition of aromatics, and (3) alkylation of aromatic hydrocarbons with chlorinated fractions, according to the Friedel-Crafts reaction. Excellent viscosity properties (as shown by viscosity index of 90-100) are reported for these synthetic lubricating oils.

● **Middle-pressure synthesis.** The industrial progress of the Kogasin synthesis was accelerated by the discovery of the "middle-pressure" synthesis by Fischer and Pichler in 1936. At pressures of 75 to 220 lb. per sq. in., an optimum yield of solid plus liquid hydrocarbons was received (Table 3). The chief advantage of this type of operation was that loss in catalyst activity was decreased. Whereas the yield dropped from 7.7 to 5.9 lb. per 1000 cu. ft. in "normal-pressure" (atmospheric) synthesis in 4 weeks, the "middle-pressure" synthesis produced 8.9 lb. initially and still was above 5.9 lb. per 100 cu. ft. after 26 weeks of operation. This synthesis

**TABLE 3**

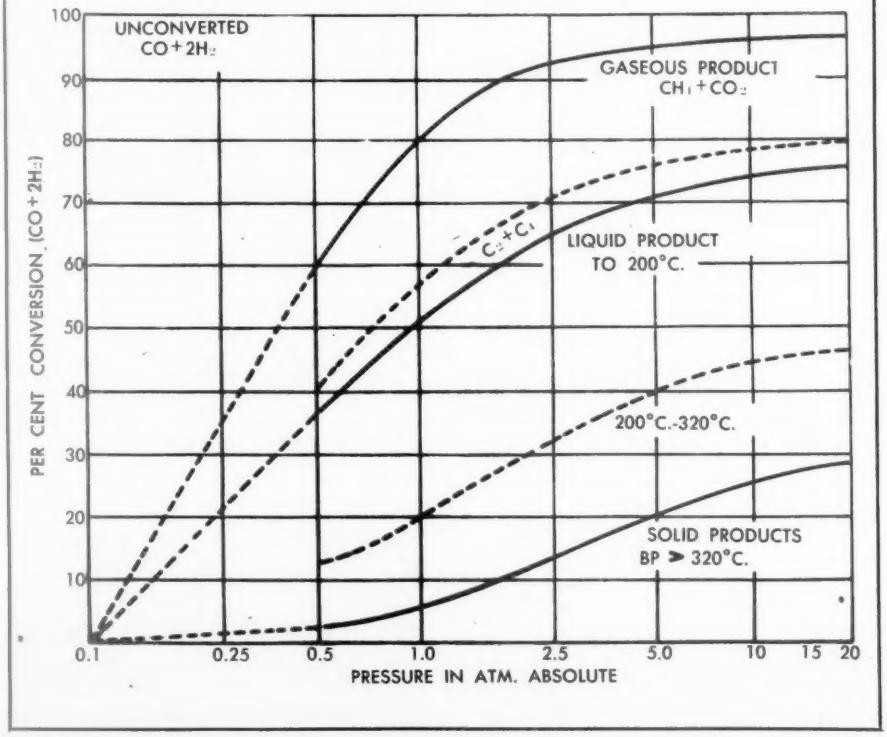
**Effect of pressure upon the yields* of hydrocarbon products.**

(Yields expressed in lb. of product per 1000 cu. ft. of gas at 60°F.)

| Pressure gauge, lb. per sq. in. | Total solid and liquid hydrocarbons | Paraffin wax | Oil above 392°F. | Gasoline below 392°F. | Gaseous hydrocarbons (including $C_3$ and $C_4$) |
|---|---|---|---|---|---|
| 0 | 6.9 | 0.6 | 2.2 | 4.1 | 2.3 |
| 22 | 7.7 | 0.9 | 2.5 | 4.3 | 3.0 |
| 74 | 8.9 | 3.6 | 3.0 | 2.3 | 2.0 |
| 220 | 8.6 | 4.2 | 2.1 | 2.3 | 2.0 |
| 735 | 8.2 | 3.2 | 2.2 | 2.8 | 1.2 |
| 2205 | 6.1 | 1.6 | 2.0 | 2.5 | 1.8 |

*Yields are average of 4 weeks operation over cobalt-thoria-kieselguhr catalyst.

**FIG. 1. Effect of pressure on total yield and yield of various fractions.**



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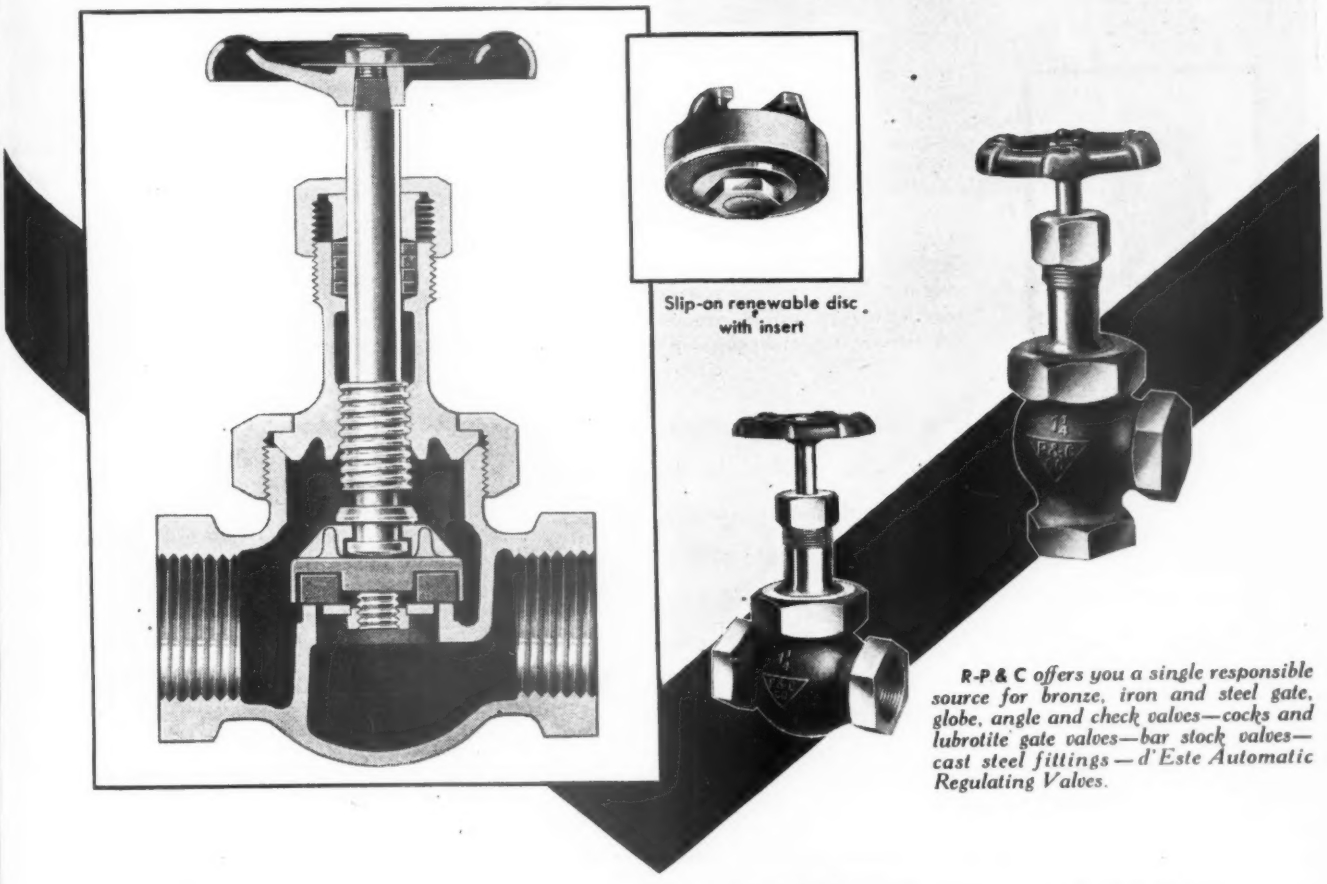

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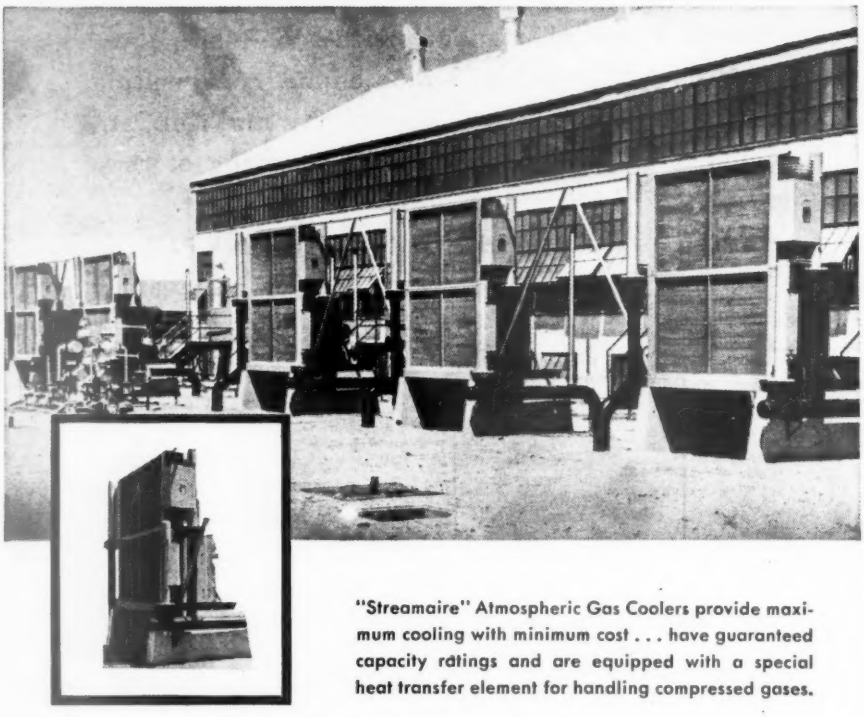

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has been performed with cobalt and iron (1937) catalysts; nickel catalysts deteriorate rapidly due to formation of nickel carbonyl at these pressures.

● **High pressure wax synthesis.** In 1938 the synthesis of high-melting wax on ruthenium catalysts at high pressures was reported. In a study of certain metals of Group VIII of the periodic table (Ru, Rh, Pd, Os, Ir, Pt), ruthenium was found to produce solid hydrocarbons more effectively than any other metal of this group. Thus, at 1500 lb. per sq. in. pressure and 383°F., 5.9 lb. of paraffin wax and 3.0 lb. of oil were obtained per 1000 cu. ft. of gas ($2H_2$:1CO) with a ruthenium catalyst. No appreciable change in the activity of the catalyst occurred in a 6-months test. By solvent extraction of a solid paraffin obtained at 1500 lb. per sq. in. pressure, a paraffin wax was obtained that had a melting point of 270-273°F. and a molecular weight of 23,000.

It can be generally noted that the increase of pressure effects the formation of higher boiling hydrocarbons. (See Fig. 1).

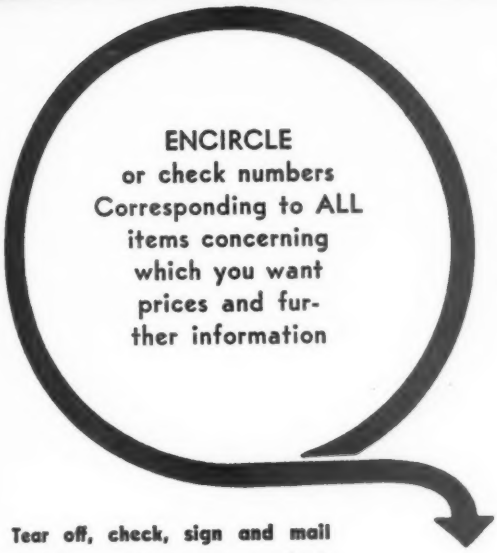
● **Iso-synthesis and napthene synthesis.** Since the start of World War II, two new syntheses have been announced, "naphthene synthesis" and "iso-synthesis." The details have not been disclosed. Both of these discoveries are due to the direction of the reaction towards the production of a specific class of hydrocarbons, e.g. in the naphthene synthesis, naphthenes and aromatics are produced. As noted previously, only saturated and unsaturated straight-chain hydrocarbons are synthesized in the Kogasin synthesis. In the production of aviation gasoline, this is a serious objection because of the low octane number of the product. However, by means of the "iso-synthesis," it is implied that iso-paraffins are produced directly and that the gasoline fractions would have high octane numbers. The $C_4$-fraction from the process contains 90 per cent of iso-butane. This, in itself, is important, since by converting half of the iso-butane to iso-butene (by dehydrogenation) and alkylation of the remaining iso-butane with the iso-butene produced, 100-octane aviation gasoline could be produced.

● **Future developments.** Future developments of the Fischer-Tropsch synthesis must proceed in the following directions:

a. The development of a sulphur resisting catalyst.
b. The utilization of carbon monoxide hydrogen mixtures of various composition.
c. The synthesis of branched chain hydrocarbons.

The last goal can probably be achieved by developing a "complex action" catalyst combining the hydrogenating, polymerizing and isomerizing ability.

★★★

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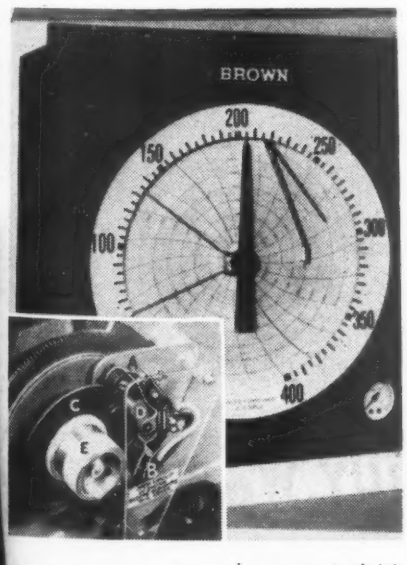
### (1) *Emergency alarm*

A new safety emergency alarm feature that protects process equipment and materials has been added by the Brown Instrument Company to its line of electronic air-operated controllers.

The new feature, known as the Brown ElectroniK Contact Controller, provides safety alarm principles that operate automatically. It also provides on-off control in addition to air control to actuate motorized valves, solenoid valves, contactor panels, signal lights, etc.

As shown in the accompanying picture of the Electronik and the contact controller, contacts (A) and (B) are made or broken by the action of cam (C) and roller (D), and the spring loaded lever to which it is attached. The control point is set by loosening the knurled knob (E) and rotating cam (C), so that its notch corresponds to the position of the temperature pen that has been previously moved to the desired point. The pen position sounds the emergency alarm. A red pointer on the scale, not shown in the picture, indicates the temperature setting of the contact controller.

The new equipment can be used in steel, petroleum, chemical, plastic, and more than 60 other major and related processing industries.

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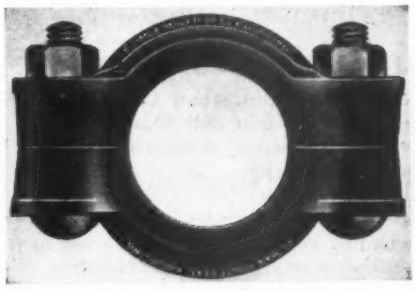
### (2) *Climax couplings*

Climax Lock Couplings, for connecting pipes used in gasoline, kerosine, steam, water, air, oil, or gas service, are offered by Hanlon-Waters, Tulsa, Oklahoma. Connections can be made rapidly, as there are only two bolts to tighten; likewise disassembly is easy, it is pointed out. The inherent flexibility of this type of coupling makes it possible to withstand shocks and vibrations. Deflection up to 5 deg. is possible. Where temperatures and pressures are subject to wide variation, the line can expand and contract. The couplings have been used on military pipe lines, which of course are subject to bombing, and earthquake areas where sharp earth movements occur.

Recommended for working pressures up to 1000 lb., Climax Couplings have been tested on swaged pipe nipple to pressures far in excess of this recommended service, to the point where pipe has burst, and in every case the couplings have remained intact and tight, according to the manufacturer.

Climax Coupling housings are made of malleable iron. Tapered bolt holes assure precision alignment without danger of pinching the seal ring. Alloy steel bolts and nuts are heat treated for 110,000 lb. minimum tensile strength. Seal rings are moulded from high grade synthetic rubber approved by governmental and civilian engineers.



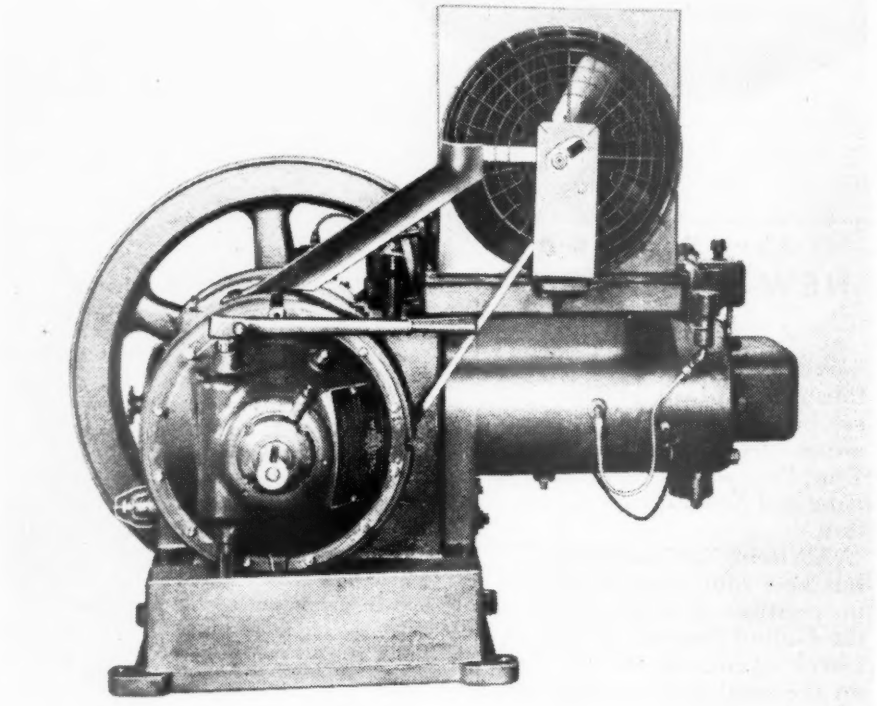
### (3) *Pumping engines*

The Continental Supply Company, Dallas, Texas, has introduced to the oil industry a new line of pumping engines to be marketed under the Continental trade mark, CSCO. The first model in the series is the CSCO-66, recently announced.

The CSCO-66 is designed and built by The Climax Engineering Company under the supervision of Continental engineers. The engine has a rated horsepower of 13.2 at 680 r.p.m. with a 5¾-in. bore and 7½-in. stroke.

The more outstanding features of the CSCO-66 are a big crankshaft with large bearings, which gives more rigid operation, and a removable wet cylinder sleeve that eliminates reboring. Other improved features embodied in the CSCO-66 are: Full pressure lubrication; twin-disk take-off, a time saver since no special sheaves or clutches are required; a fully enclosed, positively operated and lubricated valve mechanism; oil damped governor, and gas-gasoline fuel system with mechanically operated fuel pump.

Distribution of the CSCO-66 has been made to all Continental Supply Company stores and is now on display and in stock at those points.



### (4) *Karbate couplings*

The National Carbon Company has now perfected four new "Karbate" pipe connections for use in the chemical and process industries.

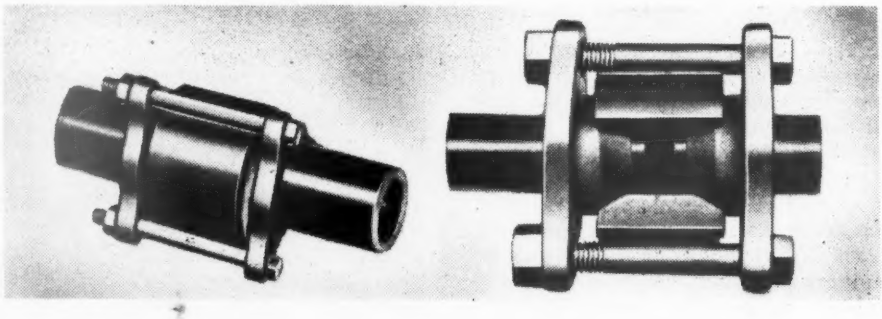
The "Karbate" chemically resistant pipe connections are made of impervious carbon or graphite, and possess the mechanical strength, and the resistance to thermal shock and corrosive liquids and gases that are characteristic of all "Karbate" specialty products.

Type FC, shown in the illustration, is a flexible coupling particularly suited to field installations or any pipe run connecting one phase of the process with another, as it eliminates the use of cements in joining lengths of pipe. The FC coupling permits sufficient pipe movement to meet all conditions encountered in the average plant.

Type V flanged connections offer all the advantages of the Van Stone type of flanges. Thickness and sturdiness of the small diameter collars provide a construction that may be used with companion flanges of almost any design or material. Separate cast-iron flanges permit easy pipe alignment and installation.

Type V nozzles and Type SC slotted couplers now available are usually factory-installed, and are particularly recommended for use on tanks, towers, heat exchangers, and similar equipment.

The four new "Karbate" connections are designed to meet the widest range of pipe requirements throughout the process and chemical industries.



### (5) *Transformer welder*

The new 200-amp. Wilson "Bumblebee" transformer welder provides a high quality a-c. machine of medium capacity, incorporating the latest features for economy in power consumption and high-speed, quality welding, according to Air Reduction Sales Company, the manufacturer.

Built-in capacitators make possible power economies up to 35 per cent, reduce power bills and power imput, and relieve overloaded transmission and plant feeder lines, making room for additional equipment. The unit is also equipped with a disconnect switch.

Self-contained, the new 200 "Bumblebee" has two ranges of current, the low from 30 to 110 amp. and the high from 90 to 275 amp. Continuous stepless current control is provided throughout each current range by simply turning the crank on the top of the machine. A full-view scale makes current settings easy to read at all times.

The machine is entirely self-contained and is sturdily constructed for dependable, economical service. All windings are covered with the latest spun-glass fiber, heat-resistant Class B non-inflammable insulation.

Copies of an illustrated leaflet, giving dimensions, operating data, electrical characteristics, graphs showing volts and efficiency and power factors percentages, and other data, are available.

### (6) *Rotary hose*

The United States Rubber Company announces the development of a new method of manufacturing rotary hose that is said to give the hose increased strength and flexibility.

The key to the new technique—called Unitension—is a special machine designed by the company's engineers that winds the main pressure-resisting wires around the rubber and fabric carcass at a scientifically determined angle.

By controlling the tension on each individual wire during this operation, the tension on all wires in all plies throughout the hose is equalized, and placement of the wires is uniform.

In laboratory and field tests this hose was found to have increased strength and flexibility, it is stated.

This improvement is being applied to both Matchless rotary hose, the type used for deep oil well drilling, and Peerless, used for average pressures.

All United States Rubber Company rotary hose incorporating the new principle of wire application is equipped with built-in couplings, providing a full hole for mud flow.

**BUY WAR BONDS**

### (7) *Gate valves*

Following up their experience in supplying large quantities of tank fittings in the synthetic rubber program, engineers of Shand and Jurs Company, Berkeley, California, announce a new valve designed for use in services where the valve is exposed to butadiene, styrene, and various sour stocks. It is a quick acting gate valve with special stem and nut design, in which the disk rises with the stem as the stem rises in the nut, thus accomplishing full opening or closing in half the number of turns customarily required. Cataloged as No. TT-135, the 4-in. size is available in steel body only, with either full brass or full 18-8 stainless steel trim. The stainless steel trim includes the stem, stem nut, disks, bonnet nut, and all moving or threaded parts. The valve seats supplied with this trim are inserted steel rings faced with a deposit of Hastelloy B, an extremely hard and corrosion resistant alloy made by the Haynes Stellite Corporation. The 6-in. valve is available with either iron or steel body. The iron body is made with brass trim only, whereas the steel valve may be had with either brass or stainless steel trim.

### (8) *Peerless separator*

The Peerless Type 4-C-5000 lb. Line Separator, shown in accompanying illustration, a product of the Peerless Manufacturing Company, Dallas, Texas, is used on injection well lines to eliminate excessive compressor outlet pressures and the blowing of injection wells to remove lubricating oil from the well sand. The separator is equipped with the Peerless Mist Extractor, which removes entrained liquid from gases.

Lubrication from the compresser piston gradually works down the line, and although the quantity is small per day, the effect is to clog up the injection well sand, requiring higher compressor pressure. Usually a pint to a quart of lubricating oil is drained from the separator daily. The Peerless Separator has been used with outstanding success for more than a year, the manufacturer states.

### (9) *Drilling Units*

Franks Manufacturing Corporation, Tulsa, Oklahoma, announces the availability of literature on its improved models SAL-5000 and SAL-6000 skid type rotary drilling units. The units are sold as complete packages including every item necessary for drilling except drill pipe, drill pipe accessories, and small tools. All parts are designed to operate as a single unit, minimizing waste power and capacities.

Using two engines rated 160 hp. at 1600-1800 r.p.m., the maximum rated capacity of Model SAL-5000, with water cooled brakes, in "hole-size depth" combinations for oil string, is from 5500 ft. of 9-in. hole using 4½-in. drill pipe to 6500 ft. of 7⅞-in. hole using 3½-in. O.D. drill pipe.

The maximum rated capacity of the Model SAL-6000, which is identical to the Model SAL-5000 except that a third engine is added, is from 7000 ft. of 9-in. hole using 4½-in. drill pipe to 8000 ft. of 7⅞-in. hole using 3½-in. O.D. drill pipe.

TD-201 United Unit in New Mexico

BUILT FOR PERFORMANCE

- 21.6 Nominal H.P.
- 107,000 Peak Torque
- Stroke 24" to 54"
- 17,000-lb. Beam Cap
- 7' Working Centers
- 12,000-lb. Weight
- Leak-Proof Bearings
- 13'-9½" Height to Beam
- Ratio 26.2 to 1
- D.O. James Double-Reduction Gear Box

*Courtesy . . . Service . . . Dependability*

*Field Stores:* Kansas, Texas, Oklahoma, New Mexico and Louisiana

United SUPPLY AND MANUFACTURING COMPANY

UNITED SUPPLY AND *Manufacturing* COMPANY

Main Office: TULSA, OKLAHOMA

NOW I ASK YOU-

- Do you really believe I am the proper person to do this sort of work? I do not!
- In fact, I am just about as efficient at this as the average sand pump or clean-out bailer is at cleaning out an oil well.
- Confidentially, if you want a real clean-out tool go to your nearest supply store and order the tops among all clean-out tools . . .

TYPE G

"THE MIDCO BAILER"

- Every individual feature of the MIDCO contributes in some degree to the almost unbelievable results obtained.
- Large volume of sales in both Domestic and Foreign fields permits maintenance of price competitive with any clean-out tool.
- Distributors located in practically all fields make replacement parts readily available.
- G-TYPE has solid steel plunger rod—exceptionally sturdy construction throughout.

Standard cable tool pin permits Jars and Sinker to be run above pump, eliminating fishing jobs.

- F-5 TYPE has patented plunger construction to assure highest possible efficiency in this type of pump.

PATENT No. 2061486
2090055 — 2090209
2176231 — 2187042
Other Patents Pending
TYPE-G TYPE F-5

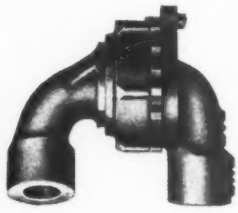
For additional information see COMPOSIT CATALOG, Page 1903
Call, wire or write

TYPE F-5

MIDCO BAILER CO.
1006 - 1012 S. E. 29th STREET
TELEPHONE 7-8586 BOX 1542
OKLAHOMA CITY - OKLAHOMA


## (10) *Flexible joints*

The development of Flexo Joints makes possible flexible pipe connections to moving machinery under high or low pressure, heat or cold. with steam, air or fluids. This remarkable development, which has served industry for many years, has made possible improved pressure and heat machinery for war production and post-war production.



The ability of Flexo Joints to swivel through 360 deg. yet maintain positive control over the flow of steam, air, fluids or suction, under high or low pressure, makes a place for this product wherever pipe flexibility is needed, the manufacturer states.

These leakproof joints consist of only four simple, foolproof parts, each one interchangeable, and made in all standard pipe sizes from ¼-in. up to and including 3-in. with threaded ends. Four different styles are available.

The standard Flexo Joint is made of bronze and designed for working pressures up to 250 lb. and temperatures not exceeding 500°F. For high pressures up to 1350 lb. and temperatures above 500° F. Flexo Joints are made of cast steel.

The joints are installed in the same manner as any pipe fitting. Maintenance cost is low, for they are so designed that there is nothing to wear but an inexpensive and easily replaced inner seal, the manufacturer asserts. By varying the composition of the inner seal, Flexo Joints may be used for almost any service. There is a full pipe area in all positions and no constriction of flow through the fitting. Any desired pipe flexibility can be obtained by using a combination of one or more styles of Flexo Joints. They may be installed on pipe lines that are moved or swung in different directions, or on machinery or equipment that must be supplied with any fluid while in motion.

The equipment is made by the Flexo Supply Company, 4230 Olive Street, St. Louis 8, Missouri.

## (11) *Bushed bearing*

A new low priced bronze bushed bearing for small shafts especially adapted for fan and blower service, known as the Type "F" Bronzoil Bearing, has been announced by the Dodge Manufacturing Corporation, Mishawaka, Indiana. This bearing is fully self-aligning. The inner housing is spherical to conform to a spherical socket in the formed steel outer housing, which permits free self-alignment and avoids cramping the shaft.

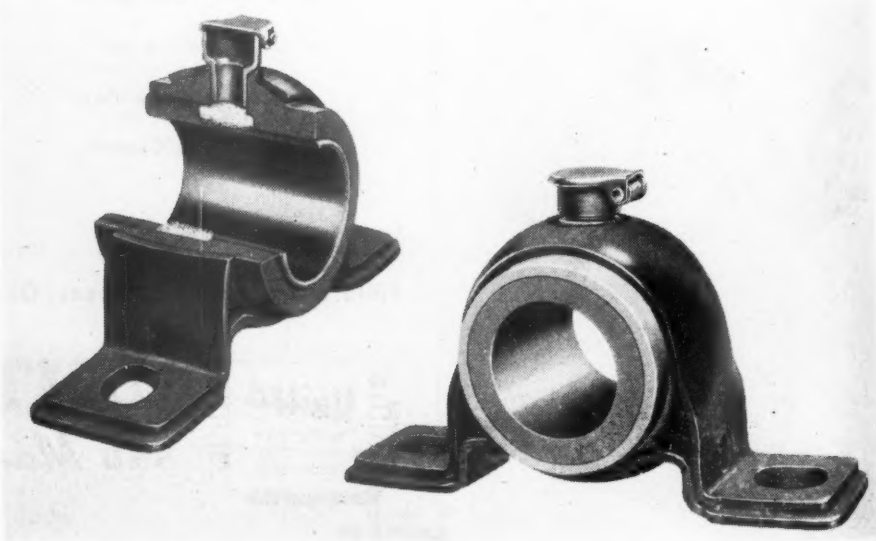
A bronze capillary bushing that carries about one-third of its volume of lubricant is used as a liner. This bushing is provided with a shoulder that offers a broad, flat bronze bearing surface that is always lubricated and serves to reduce friction between the bearing and the collar that positions the shaft.

The bearing is compact. The frontal area, which measures the obstruction to air flow, has been considerably reduced, which results in greater volumetric efficiency of the blower.

The provision for lubrication is simple and adequate. A liberal oil reservoir with a close fitting wick surrounds the bronze capillary bushing and supplies the required amount of oil as needed. Wick and oil cup are supplied with bearing.

The formed steel base is unique and provides strength and rigidity. The base is sprung slightly when hold-down bolts are tightened, which insures proper pressure when between inner and outer housing. This permits free self-alignment while maintaining the inner housing in its correct position. The feet of the base are flat and will not collapse under the heaviest pull exerted by the hold-down bolts.

Sound isolation can be provided by using neoprene oil resistant grommets, which are available at small additional cost.



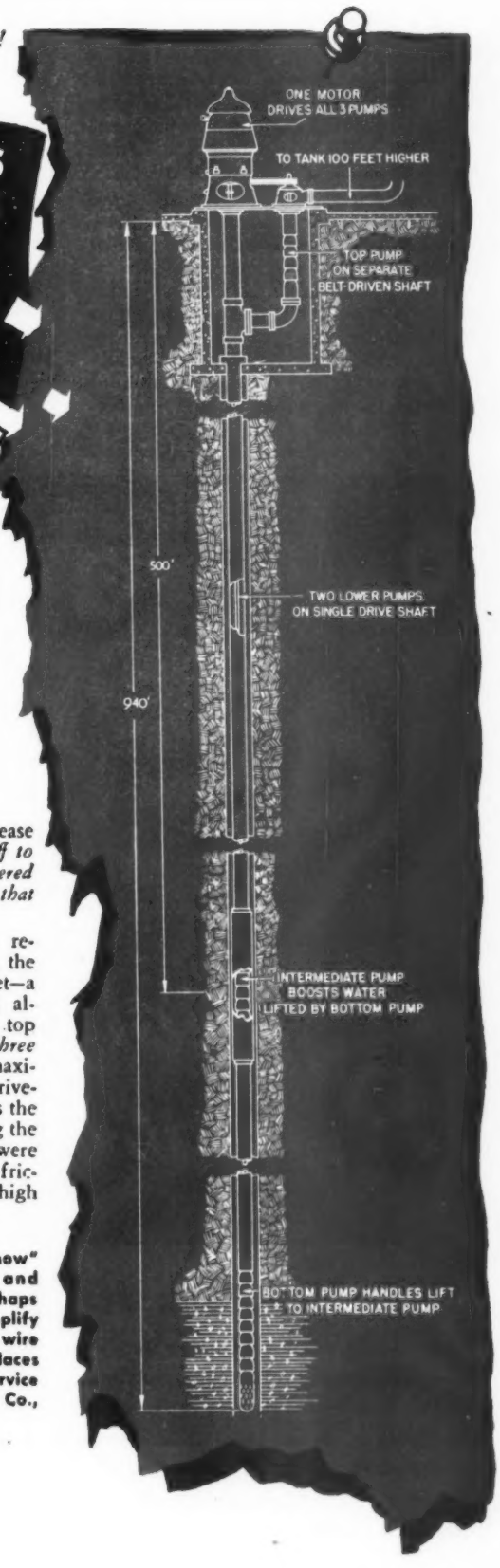
*Another page from the widespread experience of Fairbanks-Morse pump engineers!*

# HOW 3 PUMPS 2 SHAFTS 1 MOTOR

were UNITIZED to solve a tough military problem!

**IMAGINE the hydraulic skill necessary to combine an integral electric drive, a belt drive, 3 pumps totaling 59 stages and 890 ft. of column pipe and shafting into one smooth-running pumping unit . . . and at the same time solve one of the toughest lubrication problems ever put to a pump manufacturer!**

Yet that's exactly what Fairbanks-Morse Pomona engineers did to meet an urgent water problem at a vital military base in the Pacific war zone. And even that is only part of the story, for the bottom pump on this installation is located *almost a thousand feet* through flint-hard rock from the motor that drives it . . . and the unit had to deliver 275 gallons per minute into a tank another 100 feet above the motor. That's an engineering job PLUS!


ONE MOTOR DRIVES ALL 3 PUMPS
TO TANK 100 FEET HIGHER
TOP PUMP ON SEPARATE BELT-DRIVEN SHAFT
500'
TWO LOWER PUMPS ON SINGLE DRIVE SHAFT
940'
INTERMEDIATE PUMP BOOSTS WATER LIFTED BY BOTTOM PUMP
BOTTOM PUMP HANDLES LIFT TO INTERMEDIATE PUMP

## The situation...

A large dependable water supply was needed at this base. To reach it almost a thousand feet of hole had to be drilled vertically through flint-hard volcanic rock—rock so hard the hole had to be kept as small as possible to make the job feasible. Yet the great depth of the well called for a man-sized pump to go into that hole—enough pump to lift the weight of a thousand foot column of water at a rate of 275 gallons each minute!

## How it was solved...

After studying the job, Fairbanks-Morse Pomona engineers decided on a 59-stage vertical turbine pump to meet the hydraulic requirements. But instead of putting this one large pump at the bottom of the hole, it was divided into three smaller units—one at the bottom (some 940 ft. deep), another midway, and the third at the surface. By thus dividing the job, size of the drive shaft and column pipe was substantially reduced because only a portion of the total power required for the pumps now had to be transmitted the full depth of the hole.

Then these engineers pulled another trick from the hat. To further reduce loads on the main shaft and also increase flow clearances, *the top pump was set off to one side on its own drive shaft and powered by a belt drive from the* same *motor that handles the other two pumps!*

Many important advantages resulted from this unique solution. First, the small hole requirements were fully met—a notable achievement in itself. Second, although almost a thousand feet separate top and bottom units, ONE motor drives *all three* units for synchronized operation and maximum ease of control. Third, since driveshaft power losses vary approximately as the *square* of the shaft diameter, by reducing the shaft size very important power savings were effected, thrust bearing loads reduced, friction losses minimized and unusually high overall efficiencies achieved!

**This is typical of the engineering "know how" that goes into all Fairbanks-Morse and Pomona Turbine Pump installations. Perhaps this unusual pump knowledge can simplify your water-moving problems. A letter, wire or phone call to your nearby distributor places this widespread experience at your service without obligation. Fairbanks, Morse & Co., Chicago 5, Illinois.**

**Write for Bulletin No. M-85!**

For smaller gallonage applications ask about Fairbanks-Morse Westco Pumps — products of the same outstanding pump skill!

# Fairbanks-Morse

*A name worth remembering*

**Diesel Locomotives • Diesel Engines • Generators • Motors • Pumps • Scales**
**Magnetos • Stokers • Railroad Motor Cars and Standpipes • Farm Equipment**

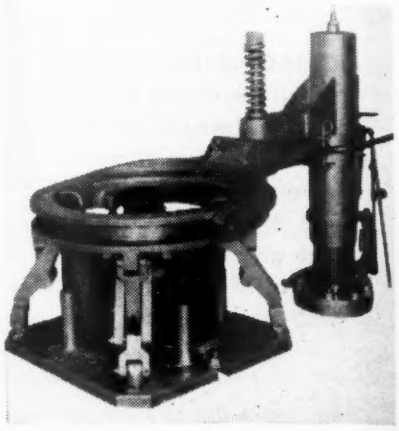
### (12) *Rotary slips*

McEvoy Company now presents to its customers in all the Gulf States, the West Coast, and abroad, the Kelco-McEvoy Air-Operated Rotary Slips, made and sold under license from the Ben F. Kelley Company of Tulsa, Oklahoma.

Already well known and used by a number of major oil companies, these slips have been employed in the drilling of many deep wells. Because of the expressed desire of many oil operators for greater automatic control to reduce to a minimum the heavy manual labor connected with rotary drilling and to obtain greater safety, a large number of operators, field engineers, and production executives have already observed these mechanically-operated slips in actual operation on the rig.

The mechanism, for purposes of description, may be divided into three parts: (1) The slip assembly, consisting of four slip segments linked both to a surrounding bowl and to a supporting ring. (2) The slip-actuating mechanism, consisting of a yoke that engages the supporting ring and is connected by an arm to a vertical post. This yoke is vertically reciprocated by means of an air cylinder incorporated in the vertical post and acting upon the yoke-supporting arm. A swivel mount permits the arm and yoke to be swung completely away from the rotary table when not in use. (3) A small air compressor.

The Kelco-McEvoy Slips are preferably operated by the driller, who has only to turn the control lever slightly



to set or release the slips. This serves to eliminate the heavy, back-breaking labor ordinarily involved in going in or coming out of the hole, particularly in deep wells.

After a thoroughgoing investigation of the performance of this equipment in the field, the research department of the McEvoy Company states that the following advantages in operation are obtained: (1) Segments are kept in perfect alignment as the slips go down in the bowl, thus preventing crushing of the pipe, which sometimes occurs when hand slips are not properly set. (2) Bearing pressure on the pipe is uniform. (3) Accidental setting is impossible. Even if air pressure goes off, a safety latch prevents the slips from setting at the wrong time. (4) Slips have extra long gripping area. (5) Irregularly worn master bushing surfaces will not affect the operation of the segments, for they are backed up by a new bowl surface inserted into the master bushing. (6) Speed of operation with high degree of safety is assured. Slips operate in unison at the turn of a single control handle, situated well away from the drill pipe. (7) The unit is dependable. Because of its simple design and rugged construction, there is little to get out of order. (8) Because of close attention paid to proper lubrication, wear is a kept at a minimum; however, simple construction makes servicing easy. A particular feature is the replaceable bowl surface. (9) Extra strong construction throughout and large gripping area make this unit suitable for use with the longest strings of pipe.

### (13) *All-wheel-drives*

With the announcement of new heavy-duty All-Wheel-Drive trucks for civilian purposes, postwar planning takes definite action at Marmon-Herrington Company, Inc., Indianapolis, Indiana.

Production is scheduled to begin soon, and is to be concentrated on two models —Model MH555-4 and Model MH440-4. The larger of these, Model MH555-4, will be powered by a 131-hp. engine, on

FOR SPECIAL JOBS! . . . . . .

The AMERICAN line of Heavy Duty Roller Bearings is not limited merely to the standard types that have made AMERICANS famous the world over. Special Roller Bearings—such as the one illustrated—include all the advantages of AMERICAN Heavy Duty Roller Bearings plus additional special features to meet your own specifications. Our engineering knowledge, resulting from years of Roller Bearing experience, is yours for the asking. Consult us about your special neds as well as for your more usual requirements.

AMERICAN ROLLER BEARING CO.
PITTSBURGH PENNSYLVANIA
Pacific Coast Office: 1718 South Flower Street, Los Angeles, California

AMERICAN
Heavy-Duty ROLLER BEARINGS

# His Fist *hit the desk*

*"If this company isn't using Gravel Packing to increase production and save repairs, we at least, ought to know why."*

PARDON the big boss for being a bit emphatic, but he's right.

When a method has demonstrated its ability to maintain greater and longer lasting well production at *reduced* maintenance cost where loose producing sand is encountered, it should be thoroughly investigated.

*Gravel Packing does just that:—*

1. It saves both initial and replacement cost of expensive screens and liners.
2. It maintains a higher rate of flow.
3. It eliminates time off production for redrilling and clean out.
4. It saves costly and recurring pump and equipment repairs.

Can your company afford to lose these advantages?

TEXACO

**TEXACO DEVELOPMENT CORPORATION**

*A Subsidiary of The Texas Company*

a wheelbase of 161 in., with a permissible gross loaded weight of 27,000 lb. on 11.00 by 20 tires. Slightly smaller, Model MH440-4 will be powered by a 118-hp. engine, on a wheelbase of 158 in., with a permissible gross loaded weight of 22,500 lb. on 10.00 by 20 tires. Both models will have 10 forward speeds and 4 reverse.

Retaining the many well-known features that Marmon-Harrington has pioneered in the multiple-wheel-drive field—low center of gravity, greater approach angle, constant velocity steering end joints, etc.—these new All-Wheel-Drives will embody also numerous design and construction refinements arising out of the company's long years of experience in producing heavy-duty military and commercial vehicles. These improvements include new double-reduction axles, powerful air brakes, and a new steering gear design that makes for easier and more positive steering control.

Nor has eye-appeal been neglected in the 1945 Marmon-Herrington All-Wheel-Drives. Cabs have been re-designed and streamlined for greater comfort and beauty, while wider, more graceful fenders not only are better to look at, but provide greater protection.

All in all, the new Marmon-Herrington All-Wheel-Drive trucks are even more rugged, more powerful, and more dependable than their famous predecessors. Big and husky, they are especially suitable for arduous duty where exceptional power, traction and stamina are "must" requirements—snow removal, off-the-road oil surveying and drilling, mining and logging operations, heavy earth-moving and construction work.

In addition to these new models, the Marmon-Herrington Company is also getting back into production, for commercial purposes, on their All-Wheel-Drive conversions of Ford vehicles. They are now offering, for reasonably prompt delivery, conversions of 1½-ton standard Ford trucks to both four-wheel-drive and six-wheel-drive and conversions of the half-ton Ford pickup truck and station wagon to four-wheel-drive.

## (14) *Safety Manhole*

When equipping oil tanks, it is always wise and safe to foresee accidental explosions.

The "Safety Manhole" of American Premaberg Company, New York, New York, operates both as a manhole and as an anti-explosion device, with the result that its use prevents the projection of the roof in case of an explosion and consequently avoids deterioration of the tanks and man accidents.

In the event of accidental overpressure, the manhole's cover goes off its seat and releases a very large volume of gas or vapors instantaneously, acting as an "over safety valve." As soon as the pressure again becomes normal, the manhole closes; but the opening has served to prevent serious deteriorations.

In addition to this advantage, the fact that the manhead falls back on its seat constitutes a means of extinguishing the fire by the shutting off of the flames.

The Premaco Safety Manhole is so designed that with a relatively small weight a considerable amount of pressure can be counterbalanced and by the displacement of the counterweight on the arm of the lever, the manhole will open only at a given pressure. The pressures to be chosen are indicated on the lever itself in pounds per square inch.

A pin arrangement makes it possible to open the manhole completely without great effort, and another provision has been made to have the manhole close positively at all times.

Guides are provided to enable the cover, even when the manhole is not in a horizontal position, to fall down in the right position.

Simplicity and strength characterize this device, the manufacturer states. It is usually built of iron and steel with lead, asbestos, or oil resistant rubber gasket depending on the product of chemical stored in the tank. The company can supply the flange and complete manhead in any alloy that resists corrosion, and can even cover with a special coating, if desired.

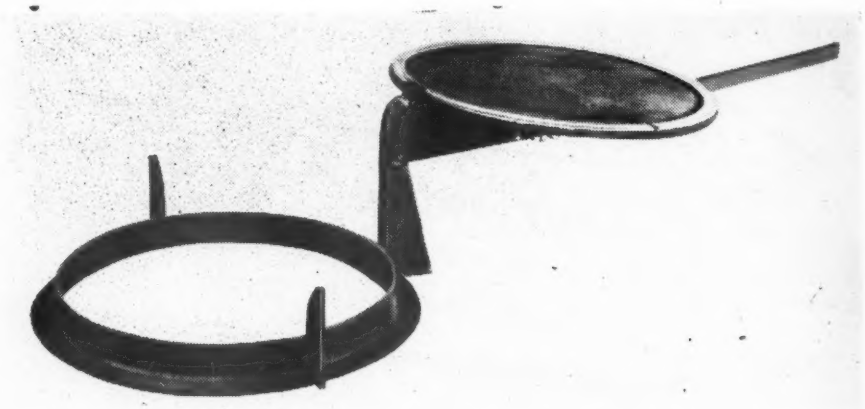
On special demand, the manhole will be supplied with gage hatch, pyrex or glass looking window and mounting collars for any kind of vent valve, with or without the vent valve itself and, if so desired, with connections prepared for a liquid level indicator.

The same device is built with opening diameters of 24 in., 20 in. or smaller sizes, operating as a gage hatch combined with a safety valve in these dimensions.

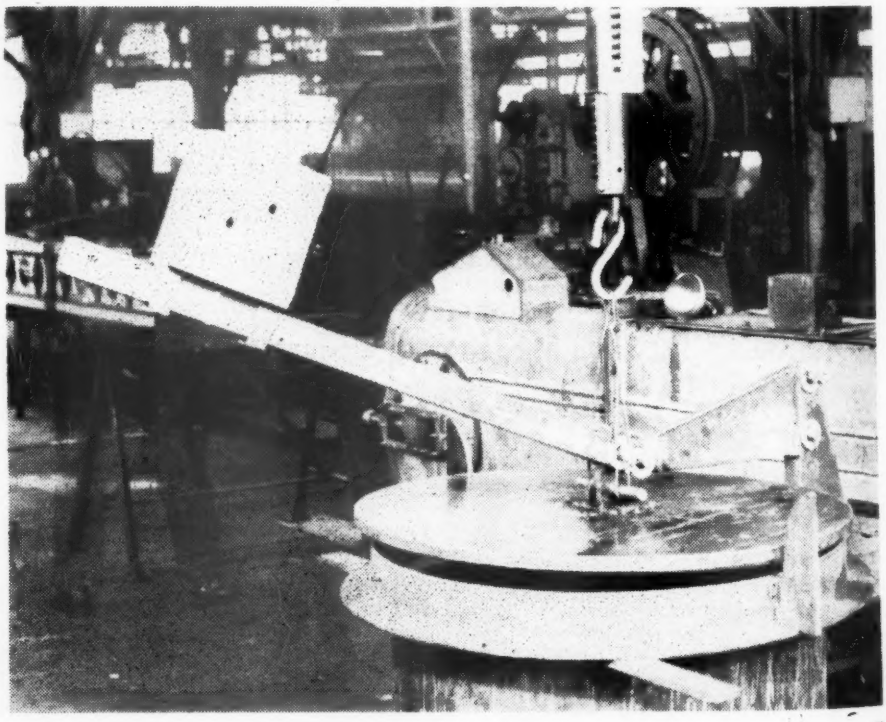
The main application of the Premaco Safety Manhole is on the roofs of petroleum product tanks and generally speaking on large containers. There are many other applications, however, such as on boilers and on any space that must be covered at certain times and be released eventually above a certain pressure; for example on turbine condensers. In that case, this device acts as an atmospheric relief valve, which protects the turbine casing by atmospheric exhaust.

The flange can be bolted or welded to the tank itself or to any nozzle.

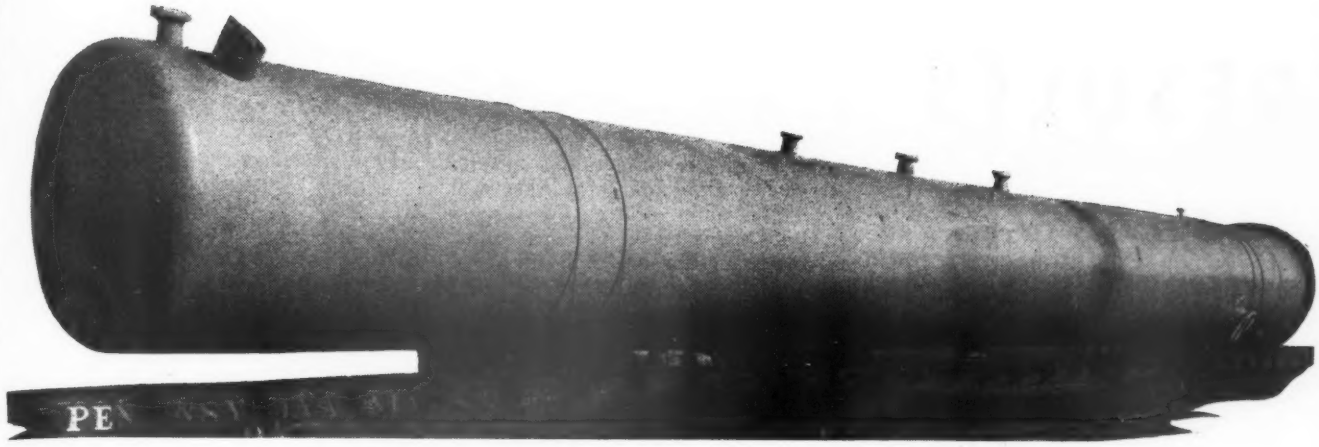
The same design can also be used with very slight modifications for ordinary manheads and for that purpose can be supplied either as the roof or shell type.



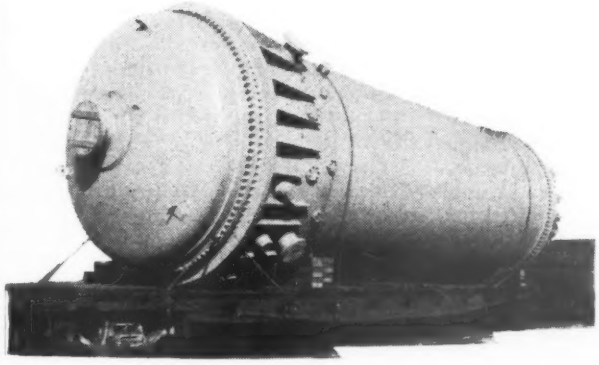
**Test showing that manway would operate as explosion hatch or emergency valve at 416 per sq. in.**



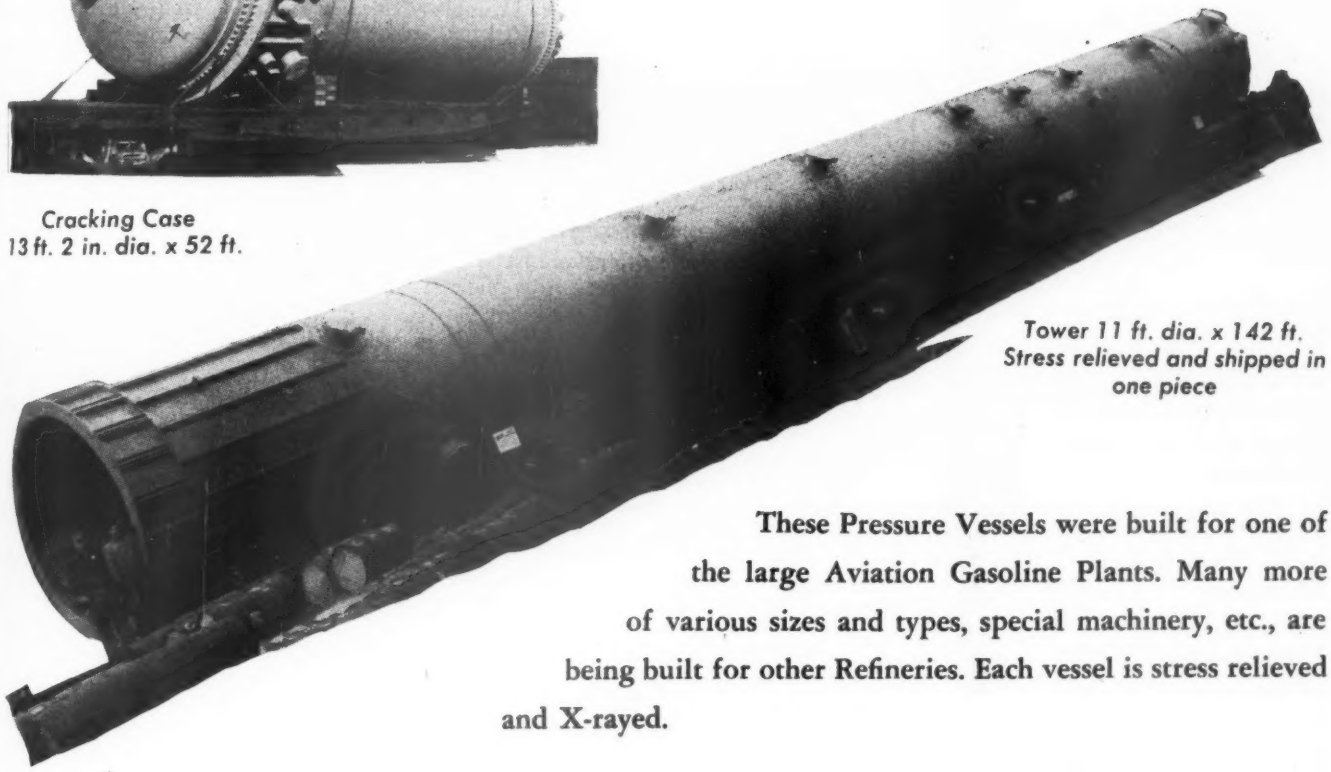
# PRESSURE VESSELS



*Fractionating Tower*
*9 ft. dia. x 105 ft.*



*Cracking Case*
*13 ft. 2 in. dia. x 52 ft.*



*Tower 11 ft. dia. x 142 ft.*
*Stress relieved and shipped in one piece*

These Pressure Vessels were built for one of the large Aviation Gasoline Plants. Many more of various sizes and types, special machinery, etc., are being built for other Refineries. Each vessel is stress relieved and X-rayed.

## SUN SHIPBUILDING & DRY DOCK CO.

**CHESTER, PENNSYLVANIA**

RELY on.....

ROBINSON

for

RESULTS

with the

REGULAR

THREE-

IN-

ONE

PACKER

You can be sure of outstanding results with this packer for—

- Shutting in gas wells.
- Flowing oil wells.
- Repressuring oil sands.
- Acidizing lime wells.

The Three-In-One Packer is designed to set and pack in the open hole.

Thick heavy rubber and a step expanding cone makes it possible to pack oversized holes or wells having irregular side walls.

It is assembled with sufficient cotter keys to hold the step expanding cone in position during transit and while lowering into the well.

P. O. Box 1408
TULSA, OKLAHOMA
*Factory:* Coffeyville, Kansas

## (15) *Slim hole pump*

Reda Pump Company, Bartlesville, Oklahoma, announces the addition of a new Slim Hole oil-well pump to the Reda line.

This new pump, designated as Series 375, is for use in "slim hole" casing—4½-in. O.D., 11 lb. per ft., 4.0-in. I.D. or larger.

This new unit, like the larger sizes, uses electric power applied at the pumping level in the well. A submergible electric motor is direct-connected to a centrifugal pump in a single assembly suspended on the discharge tubing and submerged below the fluid level in the well. A cable transmits electricity to the motor, thus solving one of the most important and difficult problems of well pumping, that of economical and efficient transmission of power from the surface to the subsurface pump, the manufacturer states.

The Reda Pump will lift crude oil, fresh water or brine, may be run in crooked holes, can be made fully automatic in operation, and permits use of small tubing, which may be protected against corrosion when desired, it is asserted.

Lower first cost and lower operating costs are claimed.

Power can be supplied from public utility lines or from individual engine generators. The complete Reda Pump installation includes motor, protector, pump, cable, starting switch, and a full string of tubing of the size required for tensile strength and good flow efficiency.

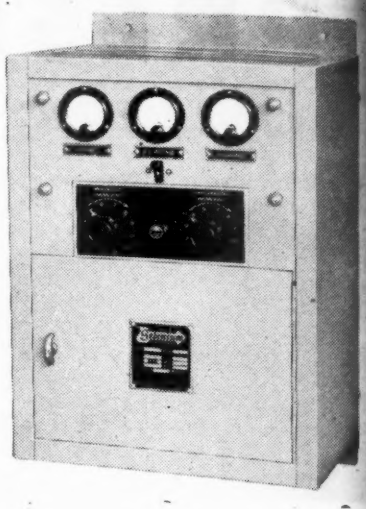
The capacity range of Series 375 Reda pumps is between 35 bbl. a day with 500 to 9000 ft. lift and 500 bbl. a day with 500 to 3000 ft. lift. The horsepower range is from ¾ to 21.

## (16) *Battery chargers*

Fully automatic telephone battery chargers for operation over a wide range of power line voltages and load requirements are being manufactured by Federal Telephone and Radio Corporaton, New York, New York, associate of International Telephone and Telegraph Corporation.

Designed to maintain telephone batteries in a fully charged condition, ready for any emergency, these well regulated and filtered chargers are ideally suited for use in manual central offices, in automatic exchanges, and in both private and rural, manual or automatic branch exchanges, the manufacturer asserts.

Federal's FTR-8000-S telephone battery chargers utilize the dependable Federal Selenium Rectifier in operation from single-phase, 60-cycle power lines of 110, 130, 200, 220, and 250 volts, selected units providing direct-current outputs ranging from 2.4 to 16 amp. for from 12 to 60 cells. Output voltage ranges from 2.1 volts per cell at high rate charge to a trickle volt charge of 2.25 volts per cell.



Battery potentials are automatically maintained within selected limits by a voltage control relay circuit that varies the charge between high and trickle rates, both of which are adjustable. The unit is designed to operate without automatic regulation if necessary, permitting the rate of charge to be adjusted manually when desired.

The d-c. output circuit is filtered to prevent the introduction of noise on telephone lines, the a-c. ripple component being guaranteed not to exceed 40 millivolts at full load. An alarm circuit is provided to indicate failure of charger or battery circuits, both of which are equipped with fuse protection and overload switches. A voltmeter on the front panel indicates battery voltage; separate ammeters show charge and load currents.

## (17) *Check valve*

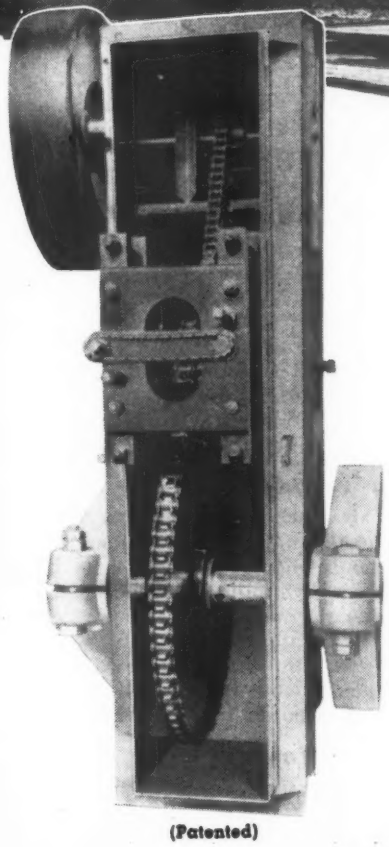
What is said to be an innovation in check valves is announced by the Harman Equipment Company, 937 Santa Fe Avenue, Los Angeles, California, in its new Permatite valve.

The valve has no poppets, disks, or other metal working parts. Back-flow is checked by a neoprene synthetic rubber tubing, which offers positive control, as the tubing easily opens with either vacuum or pressure, permitting direct flow, and closes when the flow is stopped, it is stated.

Valve installations and servicing are greatly simplified, say the manufacturers. No manholes, sleeves, or extractor equipment are required when valves are buried, as the tubing is permanently tight and its opening and closing movements are such as to prevent foreign matter from fouling the valve or causing leakage.

Laboratory tests for periods exceeding 24 hr. show that immerged in water the Permatite valve maintains a 28-in. vacuum, and that the valve acts as a check against back-flow under a static head of 29 in. without showing evidence of leakage.

BUY WAR BONDS



(Patented)

## LEE C. MOORE—*CHAIN DRIVEN UNIT*

Designed with a minimum of power transmitting parts, there is less chance of unit break-downs. When adjustment is required, a simple chain tightening device permits accurate adjustments of the chains to be made in the field, without special tools. And if repairs are necessary to power transmission parts it's easy to replace a link in the chain, without taking the unit out of service.

*Lee C. Moore Pumping Units permit a wide range of pumping speeds with the various types of prime movers. These units can be supplied from stock in most fields.*

# TRADE LITERATURE

*Publications listed are sent free upon request.*

### (18) *Testing machine*

Airco Export Corporation, formed to handle all exports of Air Reduction Company, Inc., its subsidiaries and associated companies, has issued a booklet entitled "The Airco Tensile and Guided Bend Testing Machine." Wherever the strength or ductility of welds are of prime importance, actual tests of welded specimens frequently must be made. This booklet illustrates and describes Airco's machine for making such tests.

### (19) *Wire rope catalog*

A. Leschen and Sons Rope Company, St. Louis, Missouri, has issued Catalog OG20 on wire rope for the oil and gas industry. Conditions encountered in oil and gas fields require wire rope designed and manufactured especially for this particular industry if best results are to be obtained, it is pointed out. The new Leschen publication describes and illustrates methods of rope making, the materials with which rope is made, etc. Various auxiliary equipment is also described in the catalog, such as splicing tools, lubricants, thimbles, and clips. A particularly valuable section of the bulletin is that on care and maintenance of wire rope.

### (20) *Rotary pumps*

Blackmer Pump Company, Grand Rapids, Michigan, has issued folder No. PS-1, which describes its line of rotary pumps for the petroleum industry.

### (21) *Portable drilling machines*

Portable drilling machines for cable-tool drilling is the subject of a bulletin issued by The National Supply Company. The machines are made in four sizes to cover the complete range of cable-tool drilling from medium to the heaviest depth requirements. The No. 2 machine has a rated capacity of 2500 ft.; No. 2A, 3500 ft.; No. 3A-6, 4000 ft., and No. 3A-6-60, 6000 ft. All are adapted to straight wire line spudding, as well as wire line beam drilling, by the use of practical mast top and beam shock absorbers of which large numbers are in successful use today, the manufacturer states.

The machines are made up in convenient size unit assemblies, which are easily detached and loaded on trucks for rapid moving.

### (22) *Refrigeration compressors*

Several types of refrigeration compressors are discussed in three bulletins issued by Worthington Pump and Machinery Corporation, Harrison, New Jersey. The three types described are: (1) The gas engine refrigeration compressors having capacities from 50 to 1000 tons; (2) the horizontal double-acting steam engine driven straight opposed type, and (3) the horizontal double-acting booster.

### (23) *Armored rotameters*

Fischer and Porter Company, Hatboro, Pennsylvania, announces Catalog 43-E, dealing entirely with armored rotameters for measuring and controlling flow rates at high pressures and temperatures. This catalog describes standard armored indicating meters and also recording or recording-controlling or totalizing armored meters with readings at the meter or at a remote location. It includes illustrations of many designs to accommodate pressures as high as 10,000 lb. per sq. in. and temperatures up to 750°F. The new developments, covered for the first time in a catalog, are the "Bead-Guide" rotameter metering tube, and the new F. & P. "Series 400" Rotaline Armored Valve Body Rotameter.

### (24) *Metal-cutting tools*

A new catalog, "Haynes Stellite Metal-Cutting Tools," which describes the high-production metal-cutting tools made from Haynes Stellite 98M2 and Star J-Metal alloys, has been published by Haynes Stellite Company, a unit of Union Carbide and Carbon Corporation.

The catalog includes descriptions, illustrations, engineering drawings, specifications, and prices for standard tools manufactured by the company. Among the tools discussed are square, rectangular, and round tool bits; boring and reaming blades; tipped tools and tool tips; grooving tools; cutoff tools; insert milling cutter blades; shell end mills; wear strips; and special tools. To aid those using Haynes Stellite tools, the booklet includes recommendations for cutting angles, speeds and feeds for turning, boring and milling various plain and alloy steels, cast-steel and cast-iron, stainless steel, bronze, brass, and aluminum.

### (25) *Melamine*

A 24-page illustrated booklet describing the many applications of the chemical melamine, in the plastics, textile, paper, leather, chemical, paint and allied industries, has been published by the American Cyanamid Company. The booklet is designed for popular appeal and supplements the numerous technical publications relating to the various applications of melamine and the chemical compounds in which it is used.

### (26) *Electrical automotive products*

Wagner Electric Corporation, 6408 Plymouth Avenue, St. Louis 14, Missouri, has recently issued a 16-page folder (form GU-86) describing briefly its entire line of electrical and automotive products: Motors, transformers, industrial brakes and controls, hydraulic brakes, air brakes, tachographs (speed-recording speedometers), NoRoL, brake lining, and brake-service tools. Also included are pictures and addresses of Wagner's 29 sales and service offices, and an airplane view of the factory.

### (27) *Mineral wool insulation*

Baldwin-Hill Company, Trenton, New Jersey, has issued a new 28-page industrial catalog describing in detail the various high and low temperature mineral wool insulations made by this firm. The book is fully illustrated and complete with application specifications, conductivity curves, and engineering data.

### (28) *Kobe service manual*

As an aid to the efficient operation of hydraulic oil pumping equipment, a new service manual has been issued giving complete directions for the maintenance of Kobe triplex pumps and power units. It is published by Kobe, Incorporated, Huntington Park, California, now one of the Dresser Industries. The service manual is divided into ten sections containing 37 pages of clearly written instructions prolifically illustrated with photographs. In addition, there are 16 plates of engineering drawings along with parts lists for ready reference.

### (29) *Feed water regulators*

An 8-page Bulletin, No. 83-C, entitled "Bailey Thermo-Hydraulic Feed Water Regulators" has been issued by Bailey Meter Company, Cleveland, Ohio. It describes and illustrates improved designs of thermo-hydraulic generators and bellows operated feed water regulator valves, suitable for feed lines ranging in size from ¾ in. to 6 in., inclusive.

A full page colored schematic illustration demonstrates the thermo-hydraulic principle, which is entirely self-contained and requires no outside source of power.

### (30) *Tournatrailer folder*

Profitable hauling with Tournatrailer from shovel or dragline is described in a new 4-page folder. Prepared for equipment owners and operators, the profusely-illustrated folder shows how the Tournatrailer cuts the cost of hauling rock and other material . . . points the way to a wider range of work through Tournapull interchangeability with Tournatrucks, Tournatrailers, Tournacranes, and Carryalls.

R. G. LeTourneau, Inc., Peoria, Illinois, is the manufacturer.

### (31) *Running-time recorder*

The Bristol Company, Waterbury, Connecticut, has published a folder, Bulletin No. OP1502, describing a newly developed machine running-time recorder. The folder gives information regarding principle of operation and method of use. Typical chart records are illustrated.

# THE *Petroleum* Engineer's CONTINUOUS TABLES

## A DAILY REFERENCE FOR OPERATING MEN

## INSTALLMENT NO. 98

A VALUABLE and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue, and 95-97, inclusive, in the July, 1945, issue.

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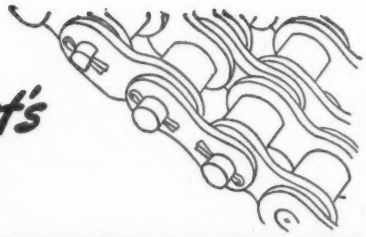
*The Riveted Chain that's*



*readily Adjustable*

# WHITNEY

## *Oil Field Assembly*

# CHAIN

## NOW CONVENIENTLY PACKAGED

As any assembly of *precision parts* should, Whitney Chains are carefully packaged to safeguard them against moisture, dirt and grit. Sealed at the factory, proper prelubrication is assured. Whitney packages make handling and shipping easier and conserve storage space. Clear labeling quickly indicates size, number and lengths. Because of the incorporation of offset links at about 25-link intervals in Whitney Oil Field Assembly Chain, adjustments for wear and elongation may be easily made by the *removal* of one or more of the offset links. Thus, by the avoidance of *new* link replacements, equal pitch is maintained in *all* links. The combination of FIXED SHAFT CENTERS and ADJUSTABLE LENGTH RIVETED CHAIN assures ECONOMICAL OPERATION:

**THE WHITNEY CHAIN & MFG. CO., HARTFORD 2, CONNECTICUT**

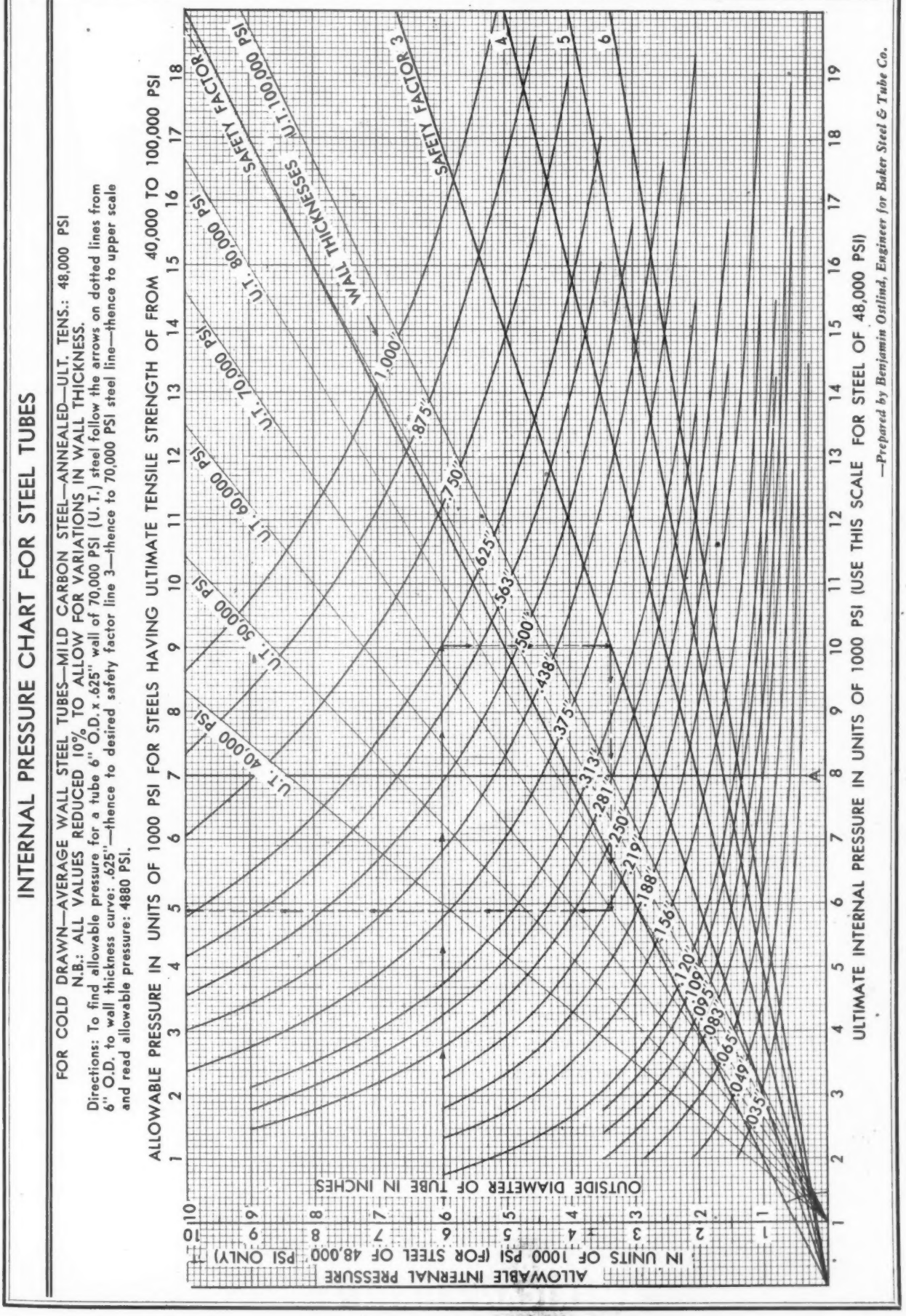
*It pays to specify WHITNEY CHAINS Distributed by*

**THE CONTINENTAL SUPPLY COMPANY, Dallas, Texas**

# INTERNAL PRESSURE CHART FOR STEEL TUBES

FOR COLD DRAWN—AVERAGE WALL STEEL TUBES—MILD CARBON STEEL—ANNEALED—ULT. TENS.: 48,000 PSI
N.B.: ALL VALUES REDUCED 10% TO ALLOW FOR VARIATIONS IN WALL THICKNESS.

Directions: To find allowable pressure for a tube 6" O.D. x .625" wall of 70,000 PSI (U.T.) steel follow the arrows on dotted lines from 6" O.D. to wall thickness curve: .625"—thence to desired safety factor line 3—thence to 70,000 PSI steel line—thence to upper scale and read allowable pressure: 4880 PSI.




—*Prepared by Benjamin Ostlind, Engineer for Baker Steel & Tube Co.*

# NEW GREEN LUBRICANT ADDS to Wire Rope Service

● The new GREEN-LUBE, made to Hazard's own specifications, clings to the wires better, thereby affording increased protection. The wires wear longer; the entire rope gives longer service. That is why every *strand* in LAY-SET Preformed I.P.S. is *packed* to the point where every void is completely filled with this superior lubricant.

LAY-SET Preformed, of Improved Plow Steel, is now completely, fully drenched with Hazard's GREEN-LUBE. This lubricant, made to our own specifications, has far greater adherence to the wires (especially the inner wires) than ordinary black compound. This means longer rope wear, better service, safer handling, higher return on the investment.

GREEN-LUBE is such a superior lubricant, we literally *pack* every strand with it. Applied hot, it coats every wire, fills every void. When cool and out in the field it sticks to those wires like no other lubricant does. Better wire movement; less friction; minimized corrosion; longer wear. Specify Hazard LAY-SET Preformed I.P.S. All-Green for your next rope.

*Distributors in all important oil field centers*

ARMY E NAVY

**Wilkes-Barre; Pa., Chicago, Pittsburgh, Houston, Wichita, San Francisco, Denver, Los Angeles, Bridgeport, Conn.**

ACCO

TRADE MARK

**HAZARD WIRE ROPE DIVISION**
**AMERICAN CHAIN & CABLE**

*In Business for Your Safety*

# GUIDE TO THE SELECTION OF CORROSION-RESISTANT PIPING MATERIALS

| | Iron and steel | Ni-resist cast iron | 18-8 mo | Monel metal | Nickel | Red brass | Acid-resisting bronze | Aluminum |
|---|---|---|---|---|---|---|---|---|
| Mercury | O | O | O | O | O | X | X | X |
| Natural gas | O | O | O | O | O | C | C | O |
| Nickel chloride (16) | * | * | C | C | C | X | X | X |
| Nickel sulphate (16) | * | * | C | C | C | C | C | X |
| Nitrating acids (water<20‰ sulphuric>15%) | C | C | C | X | X | X | X | X |
| Nitrating acids (water>20‰ sulphuric<15%) | X | X | C | X | X | X | X | X |
| Nitrating acids (water>20‰ nitric<15%) | X | X | X | X | X | X | X | X |
| Nitrating acids (sulphuric+Nitric=1% or less | X | C | O | X | X | X | X | O |
| Nitric acid, crude | X | * | C | X | X | X | X | C |
| Nitric acid, pure (17) | X | * | O | X | X | X | X | C |
| Oleic acid | C | C | O | O | * | C | O | O |
| Oxalic acid | C | C | * | O | * | C | O | O |
| Oxygen | O | * | O | O | * | C | O | O |
| Palmitic acid | C | C | O | O | * | C | O | O |
| Petroleum oils, not refined | O | O | C | * | * | C | C | * |
| Petroleum oils, refined | O | O | O | O | O | O | O | O |
| Phosphoric acid, crude | C | * | C | C | C | X | X | X |
| Phosphoric acid, pure (<45%) | X | * | O | C | * | X | C | X |
| Phosphoric acid, pure (<45%, cold) | X | * | O | C | * | X | X | X |
| Phosphoric acid, pure (<45%, hot) (18) | X | * | C | C | X | X | X | X |
| Picric acid (molten) | O | * | O | X | X | X | X | * |
| Picric acid (aqueous solution) | C | * | O | X | X | X | X | O |
| Potassium chloride | O | O | C | O | O | O | O | C |
| Potassium hydroxide | C | O | C | O | O | X | X | X |
| Potassium sulphate | O | O | C | O | O | O | O | O |
| Propane gas (5) | O | O | O | O | O | O | O | O |
| Soda ash or sodium carbonate | O | O | O | O | O | C | C | X |
| Sodium bicarbonate or baking soda | C | O | O | O | O | C | O | C |
| Sodium bisulphate | X | C | C | O | O | C | O | C |
| Sodium chloride | O | O | C | O | O | O | O | C |
| Sodium cyanide | O | C | O | C | C | X | X | X |
| Sodium hydroxide | O | O | C | O | O | C | C | X |
| Sodium hypochlorite | X | C | C | C | C | X | X | X |
| Sodium metaphosphate | C | * | O | O | * | C | O | O |
| Sodium nitrate | O | O | O | O | O | C | C | O |
| Sodium perborate and sodium peroxide | C | O | O | O | O | C | C | O |
| Sodium phosphate (mono-basic) | C | * | O | O | O | C | O | O |
| Sodium phosphate (di-basic) | C | O | O | O | O | O | O | O |
| Sodium phosphate (tri-basic) | O | O | O | O | O | X | X | X |
| Sodium silicate | O | O | O | O | O | X | X | X |
| Sodium sulphate | O | O | C | O | O | O | O | * |
| Sodium sulphide | O | O | O | O | O | X | X | X |
| Sodium thiosulphate or "hypo" | C | * | O | C | C | X | X | C |
| Sludge acid | X | C | X | C | * | X | C | X |
| Stearic acid | C | C | O | O | O | C | C | O |
| Sulphur | O | C | C | O | C | X | X | O |
| Sulphur chloride | C | O | C | O | O | X | X | * |
| Sulphur dioxide, dry (19) | O | O | O | O | * | O | O | O |
| Sulphur trioxide, dry (20, 21) | O | O | O | O | * | O | O | O |
| Sulphuric acid (98% to fuming) (23) | O | O | C | X | X | X | X | C |
| Sulphuric acid (75-95%) (22) | O | * | X | X | X | X | X | X |
| Sulphuric acid (10-75%) (22) | X | C | X | O | C | X | C | X |
| Sulphuric acid (<10%) | X | C | C | O | C | C | O | X |
| Sulphurous acid | X | * | O | O | X | X | O | C |
| Tar | O | O | O | O | O | O | O | O |
| Tartaric acid | X | C | O | O | O | C | O | O |
| Toluene or toluol | O | * | * | O | * | O | O | O |
| Trichloroethylene (7) | C | C | C | O | O | C | C | * |
| Water, acid mine (containing oxidizing salts) | X | C | O | X | O | X | X | X |
| Water, acid mine (no oxidizing salts) | C | O | X | O | O | C | O | X |
| Water, fresh (boiler feed, etc.) | O | O | * | O | O | O | O | C |
| Water, distilled (laboratory grade) (23) | X | X | O | C | O | X | X | O |
| Water, distilled (return condensate) | O | O | O | O | O | O | O | O |
| Water, salt (sea water, etc.) | C | O | C | O | C | O | O | C |
| Zinc chloride | C | C | X | O | * | X | X | X |
| Zinc sulphate | C | O | * | O | * | C | C | * |

**Reference notes**

(16) Commonly encountered as constituents of nickel plating solutions, when equipment should be lead. lead-lined, Duriron or rubber-lined.

(17) Straight chromium alloys used in preference to chromium-nickel alloys when feasible.

(18) Special high chromium-nickel alloys required.

(19) When gas is wet apply recommendations for "Sulphurous Acid."

(20) When gas is wet apply recommendations for "Sulphuric Acid (<10%)."

(21) Sulphur trioxide, either as a constituent of fuming sulphuric acid or when being handled as a gas, is capable of penetrating cast iron along the grain boundaries and causing intergranular cracking. Much cast iron equipment is used, but safety considerations suggest that steel should be used wherever possible.

(22) Special high chromium-nickel alloys having good resistance to a wide range of concentrations are being used. Ordinary iron and steel good where concentration remains over 90%. Absorption of moisture from the air dilutes exposed acid and makes it more corrosive to iron.

(23) Current practice in many cases where a mineral free water is required is to use the effluent from a softener employing "hydrogen" zeolites. Such water may be distinctly "acid" and correspondingly corrosive. Final application may require that it be handled in rubber lined pipe or in piping made of stainless steel, monel metal, etc.

O–Can be and is being effectively used.
X–Should not be used.
C–Proceed with caution. Used where corrosion is permissible; for temporary installations; where cost of better materials is too high, etc.
*–Information lacking.

*—From chart prepared by L. G. Vande Bogart, research engineer, Crane Company.*

# ROTARY TABLES TURN FASTER
## ON TORRINGTON ANGULAR CONTACT BEARINGS

*X-section shows typical application of Torrington Angular Contact Bearings to rotary tables. This is one of many applications of sturdy, efficient Torrington Bearings to outstanding oil field machinery.*

Because they are specifically designed to take unusual radial and thrust loads on fast-turning rotary tables, Torrington Angular Contact Bearings are widely specified by leading manufacturers of oil field equipment.

Rigid control in the hardening and grinding process insures precision, equalized load distribution, and long, trouble-free life under all service conditions.

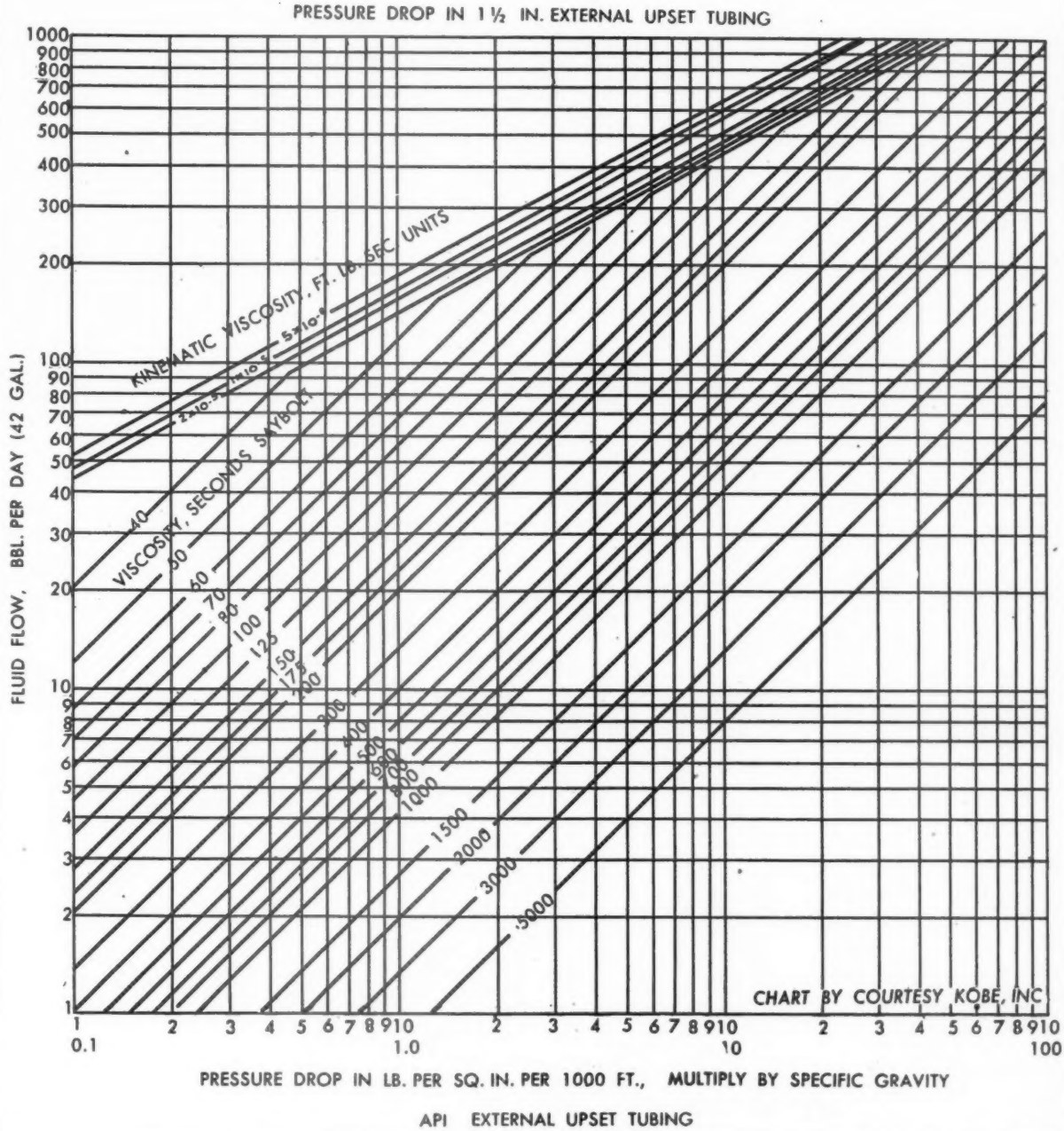
Designing and building bearings that help oil field machinery work faster and more efficiently is a specialized function of Torrington's Bantam Bearings Division. Why not follow the lead of outstanding manufacturers and operators by consulting us on all anti-friction problems, routine or unusual?

**THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION**
**SOUTH BEND 21, INDIANA**

# TORRINGTON BEARINGS

**STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL**

## PRESSURE DROP CALCULATION CHARTS




*Note:* This chart is not applicable in cases where gas is present in sufficient quantity to break out of solution, or where the fluid characteristics are not uniform.

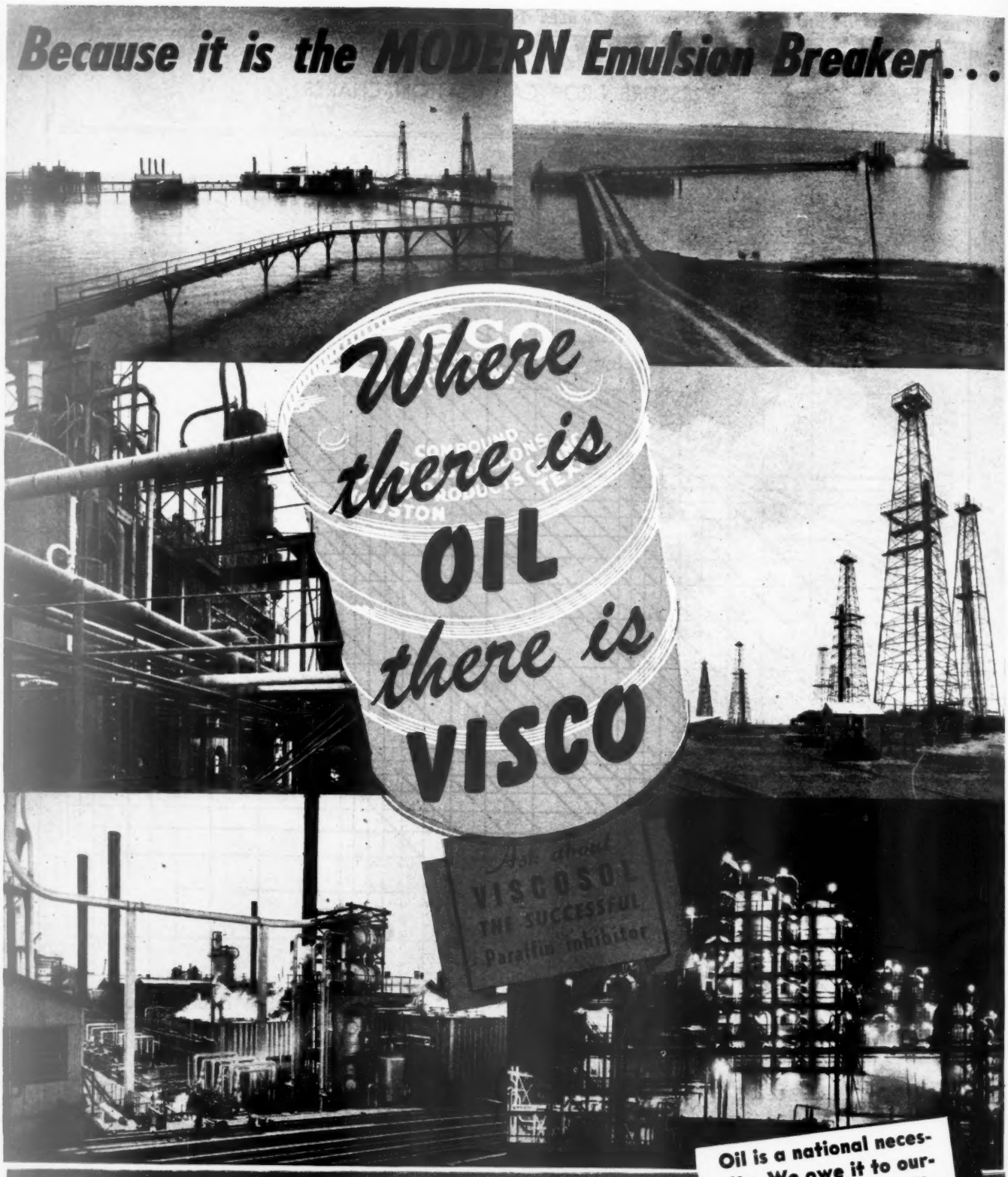
**Example:**

*Given:* Rate of flow = 100 bbl. per day.
Viscosity of fluid = 100 sec. Saybolt.
Specific gravity = 0.82.

*Wanted:* Pressure drop through 5000 ft. of 1½ in. E.U.E. tubing.

*Solution:* Beginning at the 100 bbl. per day point on the fluid flow scale follow the horizontal line to the right to the point where this line crosses the 100 viscosity-sec. Saybolt line. Continue straight downward from this point and read the pressure drop = 2.3 lb. Multiply this figure by 0.82 gravity. This gives the pressure drop per 1000 ft. under these conditions = 1.89 lb. Multiply the result by 5 (the number of 1000's of ft.). The answer is the result of the last multiplication:

The pressure drop = 9.45 lb. through 5000 ft. of 1½ in. E.U.E. tubing when the rate of flow is 100 bbl. per day, the viscosity 100 sec. Saybolt, and the specific gravity 0.82.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# VISCO

**VISCO PRODUCTS COMPANY, INC., Houston, Texas**

# PHYSICAL CONSTANTS OF PARAFFIN HYDROCARBONS

## CONSTANTS USED IN CALCULATIONS

Atomic Weights: Carbon—12.01; Hydrogen—1.008; (Handbook of Chem. & Phys., Hodgman).
1 Gal. = 3785.33 Milliliters. 1 Cu. Ft. = 28.316 Liters. 1 Lb. = 453.59 Grams.
1 Mol = 379.498 Cu. Ft. of perfect gas @ 14.696 lb./sq. in. abs. and 60° F.
Perfect gas @ 32° F. 14.696 lb./sq. in. abs. = 22.414 liters/gram mol.
760 mm. Hg. = 14.696 lb./sq. inch. 0°F. = 459.58° Rankine.
Density of Water @ 60° F. = 8.327 lbs./gal. = 0.999015 g./cc.
Sp. gr. @ 60/60° F. × 0.999015 = Density at 60° F. in g./cc.
Molecular Weight of Air = 28.966. 1 cu. ft. = 7.480 gal.

## EXAMPLES OF CALCULATIONS

DENSITY CONSTANTS OF LIQUID (Example N-Octane)

Correcting Sp. Gr. to 60/60° F.

Spr. Gr. of N-Octane at 20/4° C. = 0.70283 (Approximate A.P.I. = 69).

From U. S. National Bureau of Standard Circular C-410, the volume correction factor for 69° A.P.I. gasoline converting from 20° C. (68° F.) to 60° F. is 0.9946.

$$\frac{0.70283}{0.9946} = 0.7066 \text{ Sp. Gr. at } 60° \text{ F. compared to water at } 4° \text{ C.}$$

Density of water at 60° F. referred to water at 4° C. $= 0.9990421 . \frac{0.7066}{0.9990421} = 0.7073$ Sp. Gr. 60/60° F.

$$\text{A.P.I.} = \frac{141.5}{\text{Sp. Gr. } 60/60° \text{ F.}} - 131.5 = \frac{141.5}{0.7073} - 131.5 = 68.6$$

$$\text{Lb./Gal.} = 8.327 \times \text{Sp. Gr.} = 8.327 \times 0.707 = 5.89$$

DENSITY CONSTANTS OF VAPOR (Example propane) (Air = 1.000)

$$\text{Sp. Gr. of vapor} = \frac{\text{Molecular weight of gas}}{\text{Molecular weight of air}} = \frac{44.094}{28.966} = 1.522$$

$$\text{Lb./M. Cu. Ft.} = \frac{\text{Molecular weight}}{\text{Cu. Ft. per Lb. Mol.}} \times 1000 = \frac{44.094}{379.498} \times 1000 = 116.2$$

$$\text{Cu. Ft. Vapor/Gal. Liquid} = \frac{\text{Sp. Gr. liquid @ } 60/60° \text{ F.}}{\text{Molecular weight}} \times \frac{22.414}{28.316} \times \frac{520.58}{491.58} \times 0.999040 \times 3785.33 = \frac{\text{Sp. Gr. liquid @ } 60/60° \text{ F.}}{\text{Molecular weight}} \times 3163.97 = \frac{0.508}{44.094} \times 3163.97 = 36.45$$

Ratio Gas Volume/Liquid Volume = 7.480 × Cu. Ft. vapor per gal. liquid = 7.480 × 36.45 = 272.7

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*—Table by courtesy of the Natural Gasoline Association of America.*

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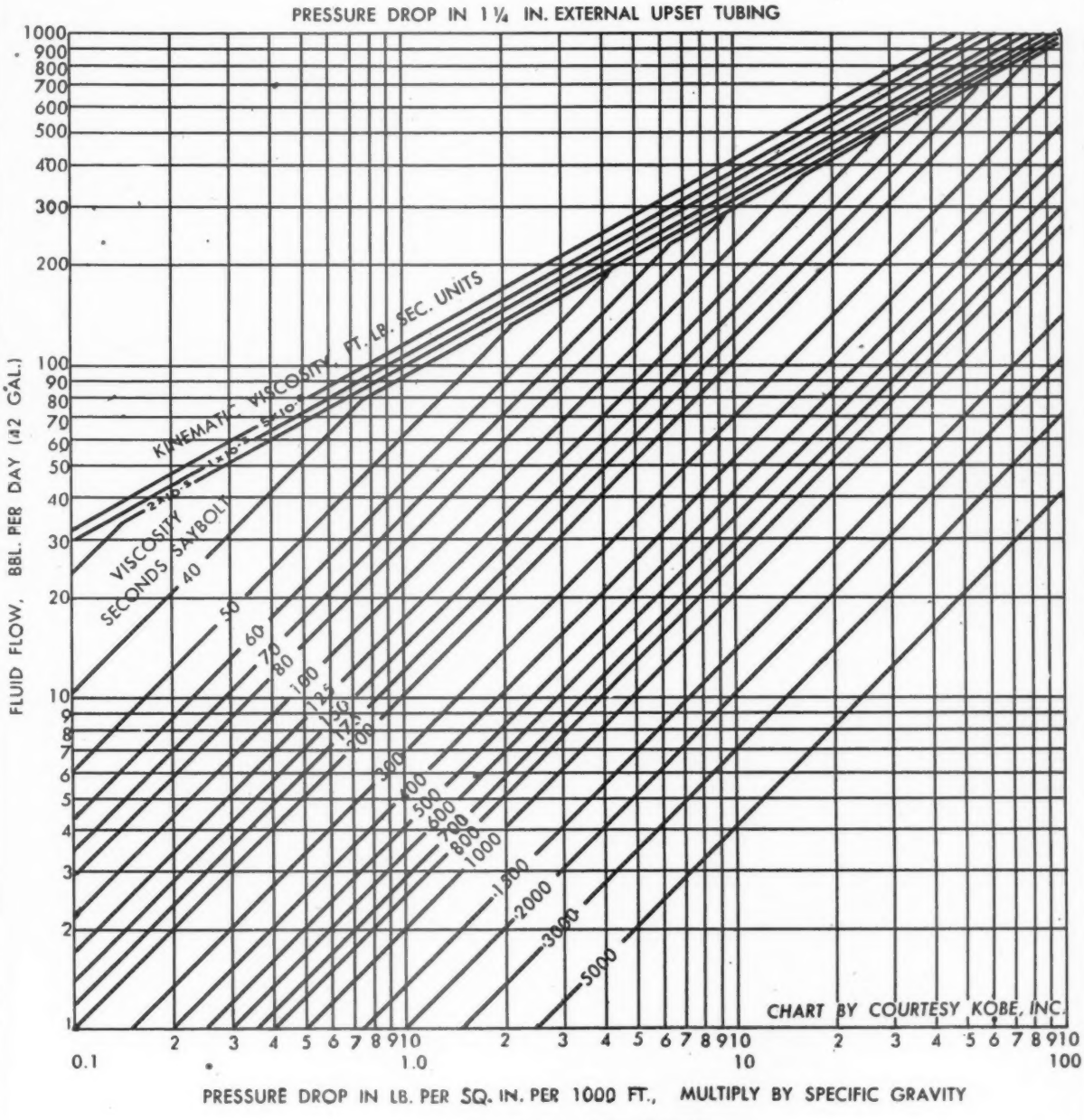
# PRESSURE DROP CALCULATION CHARTS




*Note:* This chart is not applicable in cases where gas is present in sufficient quantity to break out of solution, or where the fluid characteristics are not uniform.

**Example:**

*Given:* Rate of flow = 100 bbl. per day.
Viscosity of fluid = 100 sec. Saybolt.
Specific gravity = 0.82.

*Wanted:* Pressure drop through 5000 ft. of 1¼ in. E.U.E. tubing.

*Solution:* Beginning at the 100 bbl. per day point on the fluid flow scale follow the horizontal line to the right to the point where this line crosses the 100 viscosity-sec. Saybolt line. Continue straight downward from this point and read the pressure drop = 4.4 lb. Multiply this figure by 0.82 gravity. This gives the pressure drop per 1000 ft. under these conditions = 3.61 lb. Multiply the result by 5 (the number of 1000's of ft.). The answer is the result of the last multiplication:

The pressure drop = 18.05 lb. through 5000 ft. of 1¼ in. E.U.E. tubing when the rate of flow is 100 bbl. per day, the viscosity 100 sec. Saybolt, and the specific gravity 0.82.

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**HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION**

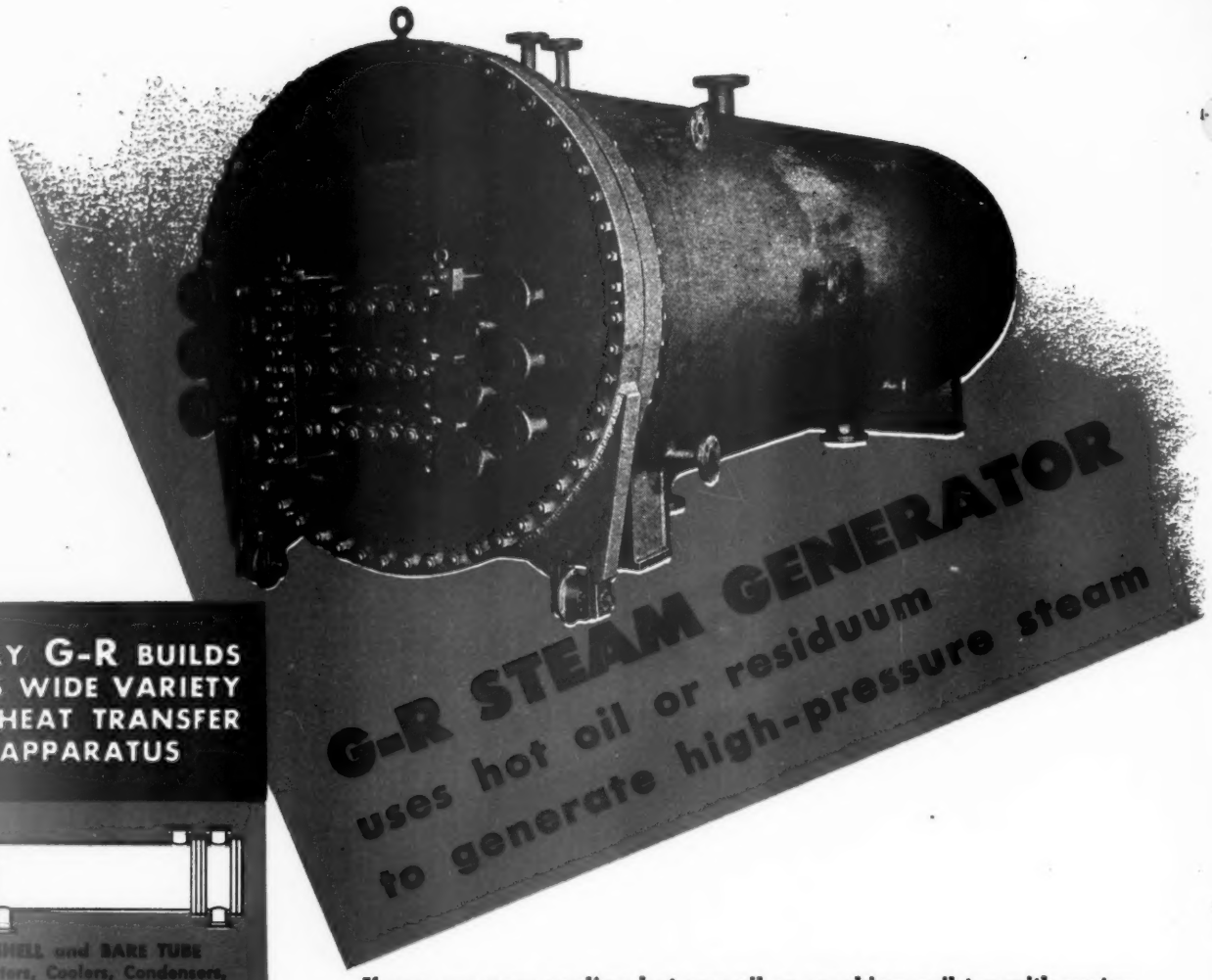
Harrison, New Jersey • Chicago • Detroit • Pittsburgh • Oakland, California

## PHYSICAL CONSTANTS OF PARAFFIN HYDROCARBONS

| | Methane | Ethane | Propane | Isobutane | N-butane | Isopentane | N-pentane | N-hexane | N-heptane | N-octane | N-nonane | N-decane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Molecular formula** | $CH_4$ | $C_2H_6$ | $C_3H_8$ | $C_4H_{10}$ | $C_4H_{10}$ | $C_5H_{12}$ | $C_5H_{12}$ | $C_6H_{14}$ | $C_7H_{16}$ | $C_8H_{18}$ | $C_9H_{20}$ | $C_{10}H_{22}$ |
| **Molecular Weight** | 16.042 | 30.068 | 44.094 | 58.120 | 58.120 | 72.146 | 72.146 | 86.172 | 100.198 | 114.224 | 128.250 | 142.276 |
| **Melting point** at 14.696 lb. per sq. in. abs. °C. | −182.5 *28* | −183.2 *38* | −187.7 *37* | −159.4 *55* | −138.3 *55* | −160.6 *29* | −129.7 *29* | − 95.4 *29* | − 90.6 *29* | − 56.8 *7* | − 53.7 *7* | − 29.7 *2* |
| °F. | −296.5 | −297.8 | −305.9 | −255.3 | −216.9 | −257.1 | −201.5 | −139.7 | −131.1 | − 70.0 | − 64.7 | − 21.5 |
| **Boiling point** at 14.696 lb. per sq. in. abs. °C. | −161.4 *24* | − 89.0 *38* | − 42.1 *9, 37* | − 11.7 **55* | − 0.5 *16* | + 27.9 *55* | 36.1 *6, 15* | 68.7 *15, 8* | 98.4 *15, 17, 35* | 125.7 *7* | 150.7 *7* | 174.0 *7* |
| °F. | −258.5 | −128.2 | − 43.8 | + 10.9 | +31.1 | + 82.2 | 97.0 | 155.7 | 209.1 | 258.1 | 303.3 | 345.2 |
| **Density of liquid** Specific gravity at 60/60°F. | 0.3** *19, 20, 21* | 0.374 *44* | 0.508 *41* | 0.563 *41* | 0.584 *23, 5, 41* | 0.625 *12* | 0.631 *14, 15, 41* | 0.664 *8, 13, 34* | 0.688 *14, 15* | 0.707 *32* | 0.722 *24* | 0.734 *1* |
| °A.P.I. | 340** | 247 | 147.0 | 119.8 | 110.8 | 94.9 | 92.7 | 81.6 | 74.2 | 68.6 | 64.5 | 61.3 |
| Lb. per gal. at 60°F. | 2.5** | 3.11 | 4.23 | 4.69 | 4.86 | 5.20 | 5.25 | 5.53 | 5.73 | 5.89 | 6.01 | 6.11 |
| Gal. per lb. mol. at 60°F. | 6.4** | 9.64 | 10.41 | 12.38 | 11.94 | 13.84 | 13.71 | 15.57 | 17.47 | 19.38 | 21.31 | 23.25 |
| **Density of vapor** 60°F. 14.696 lb. per sq. in. abs.*** Specific gravity (air=1.00) | 0.554 | 1.038 | 1.522 | 2.006 | 2.006 | 2.491 | 2.491 | 2.975 | 3.459 | 3.943 | 4.428 | 4.912 |
| Lb. per M. cu. ft. | 42.27 | 79.23 | 116.2 | 153.1 | 153.1 | 190.1 | 190.1 | 227.1 | 264.0 | 301.0 | 337.9 | 374.9 |
| Cu. ft. vapor per gal. liquid | 59** | 39.35 | 36.45 | 30.65 | 31.79 | 27.41 | 27.67 | 24.38 | 21.72 | 19.58 | 17.81 | 16.32 |
| **Ratio, gas vol. per liquid vol.*** | 443** | 294.3 | 272.7 | 229.3 | 237.8 | 205.0 | 207.0 | 182.4 | 162.5 | 146.5 | 133.2 | 122.1 |
| **Critical conditions** Temperature, °C. | − 82.5 *24* | + 32.3 *39, 36* | 96.8 *30* | 134.0 *24* | 152.0 *39* | 187.8 *24* | 197.2 *24* | 234.8 *24* | 267.0 *17* | 296.0 *24* | 322.2 *33* | 346.1 *33* |
| Temperature, °F. | −116.5 | + 90.1 | 206.2 | 273.2 | 305.6 | 370.0 | 387.0 | 454.6 | 512.6 | 564.8 | 612.0 | 655.0 |
| Pressure, atmospheres | 45.8 *24* | 48.2 *39* | 42.0 *30* | 36.1 *2* | 37.5 *39* | 32.8 *24* | 33.0 *24* | 29.5 *24* | 27.0 *17* | 24.6 *24* | 22.9 *33* | 21.2 *33* |
| Pressure, lb. per sq. in. abs. | 673 | 708 | 617 | 530 | 551 | 482 | 485 | 434 | 397 | 361 | 337 | 312 |
| Density, lb. per gal. | 1.351 *25* | 1.695 *39* | 1.888 *25* | 1.946 *25* | 1.891 *39* | 1.955 *25* | 1.935 *25* | 1.958 *25* | 1.957 *25* | 1.942 *52* | 1.935 *54* | 1.919 *54* |
| Volume, cu. ft. per lb. mol. | 1.586 | 2.371 | 3.123 | 3.990 | 4.130 | 4.930 | 4.98 | 5.88 | 6.84 | 7.86 | 8.86 | 9.91 |
| **Gross heat of combustion** B.t.u. per lb. vapor* | 23,920 *3* | 22,350 *3* | 21,690 *3* | 21,290 *5* | 21,340 *3* | 21,060 *40* | 21,120 *3* | 20,970 *3* | 20,860 *3* | 20,780 *3* | 20,710 *3* | 20,660 *3* |
| B.t.u. per cu. ft.* | 1,011 | 1,771 | 2,521 | 3,259 | 3,267 | 4,003 | 4,015 | 4,762 | 5,507 | 6,255 | 6,998 | 7,745 |
| B.t.u. per gal. liquid at 60°F. | | 68,900 | 91,300 | 99,300 | 103,000 *56* | 108,700 | 110,000 *56* | 114,900 *56* | 118,500 *56* | 121,300 *56* | 123,500 *56* | 125,300 *56* |
| **Explosion limits**—Lower per cent in air | 4.9-6.2 *31* | 3.0-3.3 *31* | 2.0-2.4 *31* | 1.80 *31* | 1.5-1.9 *31* | 1.32 *45* | 0.3-2.5 *31* | 1.1-1.3 *31* | 1.0-1.1 *31* | 0.95 *45* | 0.83 *45* | 0.67 *45* |
| —Upper per cent in air | 12.7-16.0 | 10.6-15.0 | 7.0-9.5 | 8.44 | 5.7-8.5 | .... | 4.5-7.5 | 4.2-6.0 | 3.6-6.0 | .... | .... | .... |
| **Cu. ft. air to burn 1 cu. ft. gas** | 9.55 | 16.71 | 23.87 | 31.03 | 31.03 | 38.19 | 38.19 | 45.35 | 52.06 | 59.67 | 66.83 | 73.99 |
| **Heat of vaporiz.** 14,696 lb. per sq. in. abs. B.t.u. per lb. at B.P. | 245 *50* | 211 *50* | 183 *50* | 158 *50* | 166 *50* | 146 *50* | 153 *50* | 146 *50* | 138 *50* | 131 *50* | 125 *50* | 120 *50* |
| **Specific heat** 14.696 lb. per sq. in. abs. Cp vapor B.t.u. per lb. °F. | 0.526 *4, 47, 49* | 0.413 *4, 47, 49* | 0.390 *4, 47, 49* | 0.406 *4, 47, 49* | 0.396 *4, 47, 49* | 0.413 *4, 47, 49* | 0.402 *4, 47, 49* | 0.406 *4, 47, 49* | 0.415 *4, 47, 49* | 0.420 *4, 47, 49* | 0.429 *4, 47, 49* | 0.436 *4, 47, 49* |
| Cv vapor B.t.u. per lb. °F. | 0.402 | 0.347 | 0.346 | 0.373 | 0.363 | 0.387 | 0.376 | 0.384 | 0.397 | 0.404 | 0.415 | 0.424 |
| N = Cp/Cv B.t.u. per lb. °F. | 1.306 | 1.189 | 1.128 | 1.088 | 1.090 | 1.066 | 1.070 | 1.057 | 1.045 | 1.040 | 1.034 | 1.028 |
| Cp liquid B.t.u. per lb. °F. | .... | .... | .... | | 0.55 at 32 *24* | | 0.55 *37* | 0.536 *53* | 0.522 *6* | 0.519 | 0.518 *48* | 0.517 *48* |
| **Vapor pressure** At 100°F., lb. per sq. in. abs. | .... | .... | 189.5 *46, 10* | 73.5 *26, 24* | 52.0 *22, 18* | 20.3 *24* | 15.5 *11, 18* | 5.0 *24, 18* | 1.63 *24, 18* | 0.54 *42* | 0.19 *42* | 0.06 *42* |
| **Aniline point °F.** | | | | 225.7 *46* | 181.2 *46* | 174.0 *46* | 159.3 *51* | 155.5 *46* | 159.1 *46* | 161.1 *46* | 166.1 *46* | 171.5 *46* |
| **Refractive Index** $N_D^{20C}$ | | | | | | 1.3540 *51* | 1.3577 *51* | 1.3750 *51* | 1.3878 *51* | 1.3976 *51* | 1.4056 *51* | 1.4120 *43* |

NOTES: 1. Sub-numerals shown with values refer to references in the bibliography shown on P 771.B. Where none are given, the values were calculated from those with references.
2. The values in the table were adopted in 1945 as standard values by the California Natural Gasoline Association and the Natural Gasoline Association of America.

*Gross heat on dry basis at 14.696 lbs./sq. in. Abs. and 60° F. To convert to water saturation basis, multiply by 0.9825.
**Apparent values for dissolved Methane @ 60° F.
***Based on "perfect gas." —*Table by courtesy of the Natural Gasoline Association of America.*

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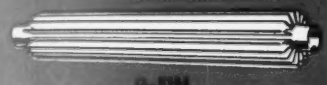

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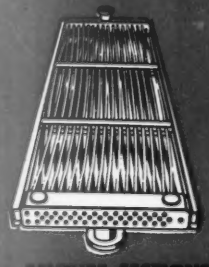
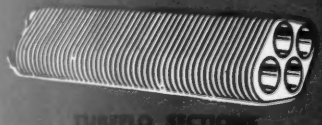


BENTUBE SECTIONS
with scale-shedding elements for hard or salt water



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## VAPOR PRESSURE BLENDING CURVES FOR COMMERCIAL BUTANE

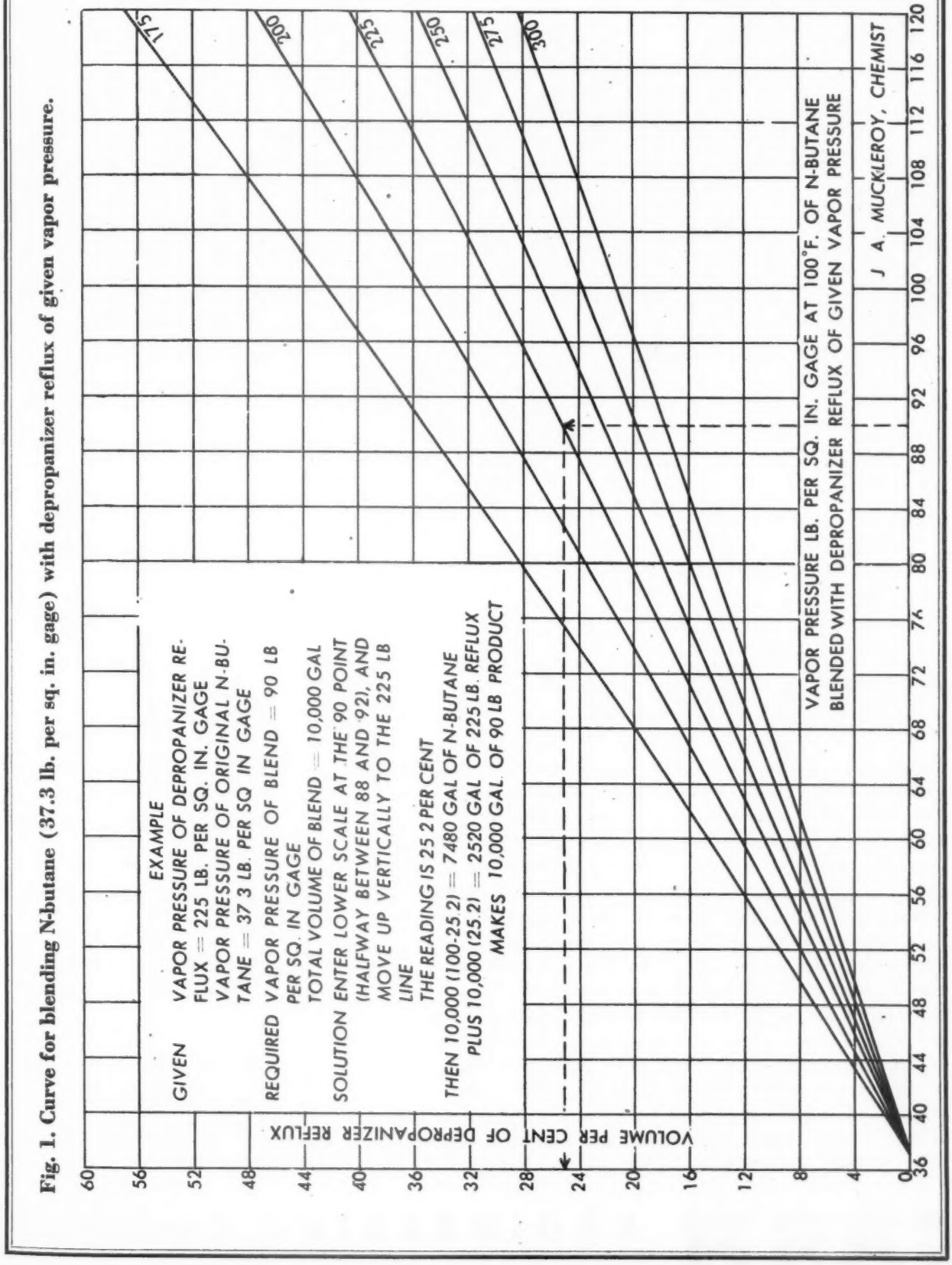
EXAMPLE
GIVEN VAPOR PRESSURE OF DEPROPANIZER REFLUX = 225 LB. PER SQ. IN. GAGE
VAPOR PRESSURE OF ORIGINAL N-BUTANE = 37 3 LB. PER SQ IN GAGE
REQUIRED VAPOR PRESSURE OF BLEND = 90 LB PER SQ. IN GAGE
TOTAL VOLUME OF BLEND = 10,000 GAL
SOLUTION ENTER LOWER SCALE AT THE 90 POINT (HALFWAY BETWEEN 88 AND 92), AND MOVE UP VERTICALLY TO THE 225 LB LINE
THE READING IS 25 2 PER CENT
THEN 10,000 (100-25 2) = 7480 GAL OF N-BUTANE
PLUS 10,000 (25.2) = 2520 GAL OF 225 LB. REFLUX
MAKES 10,000 GAL. OF 90 LB PRODUCT
175
200
225
250
275
300
VOLUME PER CENT OF DEPROPANIZER REFLUX
VAPOR PRESSURE LB. PER SQ. IN. GAGE AT 100°F. OF N-BUTANE BLENDED WITH DEPROPANIZER REFLUX OF GIVEN VAPOR PRESSURE
J A. MUCKLEROY, CHEMIST

**Fig. 1. Curve for blending N-butane (37.3 lb. per sq. in. gage) with depropanizer reflux of given vapor pressure.**

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The ability of Nash Compressors to maintain original performance thruout a long life is only one of the many advantages which derive from the Nash liquid piston principle of compression.

Since this liquid piston is an integral part of the Nash Compressor, additional liquid can do no harm to the pump structure, whether in the form of slugs entering by accident, or as condensate forming in the suction lines. In handling gases, for example, wet hydrocarbons, usual elaborate protective devices are eliminated. The hazards of such devices are therefore avoided, the cost of installation is saved, and freedom from repairs and shutdowns is assured.

Nash Compressors produce 75 lbs. pressure, or vacuums to 26 in. of mercury, in a single stage. with capacities to 6 million cubic feet per day in a single structure. They have but one internal moving part, simple and non-wearing. There are no valves, gears, pistons, sliding vanes, or other enemies of long life. No gas contaminating internal lubricant is employed. Compression is without pulsation. It will be to your advantage to investigate the Nash Compressor.

**26 in. mercury vacuum or 75 lbs. pressure in one stage.**

**No internal wearing parts.**

**No internal lubrication to contaminate gas handled.**

**Desired delivery temperature automatically maintained.**

**Non-pulsating pressure.**

**Original performance corstant over a long pump life.**

**Low maintenance cost.**

**NASH ENGINEERING COMPANY**
**286 WILSON, SO. NORWALK, CONN.**

# Running Tour WITH MEN IN THE INDUSTRY

● **E. W. Krug** has returned to the staff of Pan American Pipe Line Company, Houston, Texas, as division superintendent. He was recently discharged from the armed forces after 28 months' service. At the time of his discharge he held the rank of major. He spent a large part of the 28 months overseas in Italy, Germany, France and Sicily.

● **Philip C. Dixon** announces the opening of his offices, as consulting petroleum and natural gas engineer, at 1315 Second National Bank Building, Houston, Texas. He was a partner in the former firm of Foran, Boatright and Dixon.

● **T. D. Slingman** has been named manager of industrial sales of Baldwin-Hill Company, Trenton, New Jersey, manufacturers of thermal insulation products. Slingman was formerly vice president of mechanical sales of The Dayton Rubber Manufacturing Company and had previously been associated with Fairbanks Morse Company, the Duriron Company and Chicago Pneumatic Tool Company.

T. D. Slingman

● **V. W. Mitchell,** formerly in the Shreveport district offices of the Republic Supply Company, has been appointed assistant district manager with headquarters in Jackson, Mississippi. Mitchell has been associated with Republic since 1935. J. B. Lionberger is district manager at Shreveport and T. C. Hendricks is assistant district manager for the territory west of the Mississippi.

● **Mendel A. Keith,** general traffic manager of International Derrick and Equipment Company, Columbus, Ohio, has been elected president of the Oil and Gas Well Supply Traffic Association. Other officers named are **L. J. Prior,** traffic manager of the National Supply Company, Toledo, first vice president; **F. R. Jones,** traffic manager of the Walworth Company, Kewanee, Illinois, second vice president; **H. C. Witt,** traffic manager of the Jones and Laughlin Supply Company, Tulsa, Oklahoma, treasurer, and **C. R. Gartrell,** traffic manager of the Continental Supply Company, Dallas, Texas, secretary.

Mendel A. Keith

● **Philip H. Bohart** of Tulsa, Oklahoma has been appointed director of the production division of PAW. Bohart, assistant to the vice president of Gulf Oil Corporation, will replace **John R. McWilliams** who recently resigned to resume his duties with Carter Oil Company, Tulsa. **Ralph J. Schilthuis** has resigned as assistant director of the production division of Paw to return to Humble Oil and Refining Company, Houston, Texas. Schilthuis is one of the few members of the original staff of PAW.

Philip H. Bohart

John R. McWilliams

Ralph J. Schilthuis

● **James L. Ray** has been appointed head of the gas and steam-turbine engineering department in San Francisco and will supervise the enlargement of the technical staff of the Joshua Hendy Works, Sunnyvale, California. Ray is former chief gas-turbine design engineer of the Allis-Chalmers Manufacturing Company. He has also been employed at Westinghouse Electric Corporation, Fairbanks, Morse and Company, and Murray Iron Works before his present appointment.

James L. Ray

● **Frank S. West** and **H. S. Cole, Jr.** have formed a partnership to engage in gasoline and cycling plant design and consulting engineering in the field of gas, natural gasoline, and condensate recovery. Both men were formerly with The Texas Company where West was chief engineer in charge of gasoline cycling plant design and construction and Cole was assistant to the manager of the producing department. The firm will be known as West and Cole and will maintain offices at Houston, Texas.

● **Howard Lamberton,** assistant general foreman, machinists department, Lago Oil and Transport Company, Ltd., Aruba, South America, was a recent visitor at the Kalamazoo, Michigan, plant of Durametallic Corporation. He was formerly associated with the Quimby Pump Company and has been in Aruba for 7½ years.

● **Dr. Wendell P. Metzner** has been transferred from St. Louis, Missouri, where he was a group leader for research in organic intermediates to Dayton, Ohio, by Monsanto Chemical Company. At Dayton, central research laboratories for Monsanto, he will head the flexible-type high polymer group. **Harold L. Hubbard** will succeed Dr. Metzner as group leader in the organic chemicals division. **Dr. Alfred G. Rossow** has also been transferred from Dayton to the St. Louis research laboratories. These announcements were made by Dr. Lucas P. Kyrides, research director of the company's organic chemicals division.

● **Andrew H. Heywood** has been appointed manager of the motor application department of the Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania, according to Leon R. Ludwig, manager of the motor division. Heywood joined Westinghouse in 1926 and served for a number of years in industrial sales, Cincinnati, Ohio. In 1944 he was appointed assistant manager of the department he will now head.

● **E. K. Hartzell,** for a number of years associated with various utility properties of Cities Service Gas Company, has been named assistant to the president of the company with headquarters in Oklahoma City, Oklahoma. He will direct the company's public and employe relations program and will supervise publicity, advertising and personnel activities.

A. G. Kirker

● **A. G. Kirker** has been appointed service engineer of the Pittsburgh Equitable Meter Company-Merco Nordstrom Valve Company in the firm's Boston district office. Kirker will handle the sale and service of Pemco-Merco products in Connecticut and Rhode Island.

● **W. F. Moore** has been appointed general manager of foreign operations for The Texas Company, Harry T. Klein, president, has announced. Moore joined the Texas company in 1920 at its Port Arthur, Texas, refinery in the power department. He remained with the refining department until 1930 when he represented the company in several official capacities in the domestic and foreign fields with patent and research affiliated interests. In 1938 he returned to headquarters as chief purchasing officer, un-

ORBIT VALVES

MASTER VALVE
WITH
UNEQUAL FLANGES

The ORBIT GEAR OPERATED MASTER VALVE makes your Christmas Tree more compact by eliminating the use of an adapter flange—also eliminating chances for additional gasket leaks. The Unequal Flanges are cast integral with the body of the Valve.

*Orbit Gear Operated Master Valve*

This valve can be furnished thru all fabricators of Xmas Trees or thru any of your local supply stores at a price comparable to that of other leading valves, YET, this valve requires no lubrication to effect a seal.

See 1944 Composite Catalog

SERVICE REPRESENTATIVES

R. G. "Bob" Cole, Houston, Texas
Phone Fairfax 0057
Warehouse 407 Velasco Street
Houston

Rex E. Galloup, Phone 6436,
Lubbock, Texas

ORBIT VALVE COMPANY
TULSA, OKLAHOMA

til 1943 when he was assigned to foreign operations as assistant to the vice president. He held the latter office until his recent appointment.

O. F. Jolly

● **O. F. Jolly,** who recently returned from the Bahrein Islands, where he has been engaged in construction work for the Bahrein Petroleum Company, is now employed as sales representative for Oil Center Tool Company, headquarters in Houston, Texas. Before going abroad, Jolly was employed for 10 years as field representative for THE PETROLEUM ENGINEER.

● **C. W. Guyatt,** formerly chief industrial engineer of American Steel and Wire Company, has been appointed assistant to C. D. King, chairman of operating committees, United States Steel Corporation of Delaware. Guyatt joined American Steel and Wire in 1935 as industrial engineer and leaves the position of chief industrial engineer to accept his present appointment. He will assist King in the establishment of production standards for all U. S. Steel subsidiary manufacturing companies.

● **John W. Crutchfield** has opened a consulting petroleum engineering office in Corpus Christi, Texas. He is former senior petroleum engineer for Humble Oil Company in the Southwest Texas Division. He will maintain offices in the Nixon Building, Corpus Christi.

● **R. E. Heithecker,** formerly senior petroleum engineer, U. S. Bureau of Mines, Bartlesville, Oklahoma, now heads the gas utilization department of the Mid-Continent division, Seaboard Oil Company of Delaware, Dallas, Texas. He went with the Bureau of Mines in 1926. For the last 6 years he has been head of the section at Bartlesville dealing with primary oil and gas production problems. He is the author of several Bureau of Mines publications.

R. E. Heithecker

● **F. J. Van Poppelen** has been appointed vice president of Salem Engineering Company, Salem, Ohio, according to Sam Keener, president. For the last 11 years Van Poppelen has filled various executive positions at the Remington Arms Company of Bridgeport, Connecticut. During the last few years he has served as chief engineer of the military division for the same company.

● **N. B. Dismukes** has been transferred from the New York office of Socony-Vacuum Oil Company to the Colombian Petroleum Company, jointly owned by Socony and The Texas Company, as chief petroleum engineer. Communications to him should be sent to the Colombian Petroleum Company, Apartado 100, Cucuta, Colombia.

● **H. M. Marks,** engineer with the Creole Petroleum Corporation, headquarters at Curacas, Venezuela, recently returned to the United States on leave-of-absence. While here he will be connected with the Lubri-Gel Products Company, McCracken, Kansas.

● **Hugh R. Lamberth,** formerly with Yaras and Company, and previously sales director for the Fluor Corporation, Ltd., now fills the post of general manager, Compania e Importadora Internacional, South America, exporters and importers, San Juan de Letran No. 9, Noveno Piso, Mexico City, D.F. The company represents J. F. Pritchard and Company in Mexico and is seeking representation for American petroleum equipment and LP gas equipment concerns.

● **J. Taylor Fly** has been elected a director and **LeRoy Wilson** has been appointed employe relations manager of

J. Taylor Fly

LeRoy Wilson

Creole Petroleum Corporation, Venezuelan affiliate of Standard Oil Company of New Jersey. A former member of Jersey Standard's Latin-American legal staff, Fly joined Creole in 1942. He is a member of the Venezuelan Chamber of Commerce, Bolivian Society and the Pan-American Society. He was elected to the Creole board at the 1945 annual meeting. Wilson has been associated with various foreign and domestic affiliates of Jersey Standard in sales, producing and personnel since 1914. He was named secretary to the producing committee and managerial assistant to the producing department in 1933. Since 1943 he has been in charge of the company's office of Argentine Coordination.

● **Gordon W. Schroedel** has been appointed controller of International Derrick and Equipment Company, according to O. M. Havekotte, president. Schroedel has been associated with Dresser Industries since April 1941. He was factory accountant with the Dresser Manufacturing division until January 1942 at which time he was appointed controller of Bovaird and Seyfang Manufacturing Company.

Gordon W. Schroedel

# CHANGE of Management AT FRANCE PACKING

E. A. France, son of Adam Warren France, who patented France Metallic Packing and founded the business nearly fifty years ago, is now president and general manager. J. C. Allen is the new treasurer. Both Mr. France and Mr. Allen have been active in the manufacture of metallic packing for many years.

The new management pledges that it will produce the same high quality metallic packing that has been operated so successfully in engines, pumps and compressors under all conditions of service for nearly half a century. Furthermore, every effort will be made to reorganize the business in order to improve service and delivery.

Remember the Name, FRANCE, Standard of the Industry.

FRANCE PACKING COMPANY
PHILADELPHIA 35, PA.


● **Gordon A. Kessler** has been appointed patent attorney to head the Houdry Process Corporation's patent division, according to A. V. Danner, executive vice president. Kessler has been employed previously by the Texas Company and Allied Chemical and Dye Corporation. He is a member of the New York bar and will maintain headquarters in the Lewis Tower Building, Philadelphia, Pennsylvania.

Gordon A. Kessler

● **R. L. Tollett** has been reelected president of the Cosden Petroleum Corporation, Big Spring, Texas. Other officers named at the meeting of the board of directors recently are **Marvin M. Miller** and **J. B. Mull,** vice presidents in charge of distribution and manufacturing respectively; **A. V. Karcher,** secretary and treasurer; **C. F. Dyckmans,** assistant treasurer; **V. A. Whittington,** assistant secretary and assistant treasurer, and **Nelson Phillips,** general counsel and assistant secretary. Board of directors includes Tollett, Karcher, Miller, Phillips, **Leo M. O'Neil, James L. Carey,** and **B. H. Roth.**

● **Laurance S. Reid,** formerly assistant chief engineer for the Southern Natural Gas Company, has been appointed professor of chemical engineering at the University of Oklahoma. Reid's duties will be divided between teaching and research.

Laurance S. Reid

● **R. O. Cox** has been promoted from chief measurement engineer to office supervisor of measurement, **R. M. Scofield** has been promoted from chief meter inspector of field supervisor of measurement, and **R. F. Downey** has been promoted from special inspector to assistant field supervisor of the Lone Star Gas Company. These promotions were announced recently by E. E. Stovall, gas measurement superintendent.

● **C. G. Gerhold** has been appointed manager of Universal Oil Products Company's Riverside research and development laboratories, according to D. W. Harris, president of the company. **R. B. Day,** manager of the laboratories for the last 7 years, resigned. **Dr. L. S. Kassel** remains with the company as technical coordinator.

C. G. Gerhold

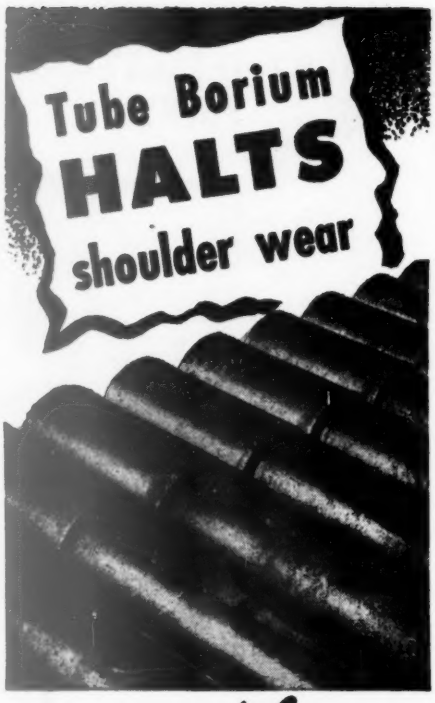

# WEIGHT INDICATOR POINTS

**THE CLIPPER SEALTITE INSURES THE ULTIMATE IN ACCURACY**

Martin-Decker has now added to the rugged, lightweight, highly adaptable Clipper Weight Indicator the advantages of Sealtite construction. This Sealtite construction eliminates the possibility of fluid leaks . . . thus the instrument can be loaded with the correct amount of non-corrosive, non-freezing fluid, then calibrated and sealed—right at the factory. Because no further adjusting or pumping is necessary, dependable accuracy is assured at all times. Especially designed for operators not requiring a chart record of their wells, the Clipper Sealtite combines fast and easy portability, complete adaptability to any weight indicator job in the field, and consistent accuracy in one compact unit.

*Easy to Read*
*Extremely Accurate*
*Completely Self-Contained*

**MARTIN-DECKER CORP.**
LONG BEACH, CALIFORNIA
A. F. McQUISTON, BAKERSFIELD, CALIFORNIA
REED ROLLER BIT CO., HOUSTON, TEXAS

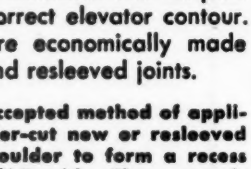


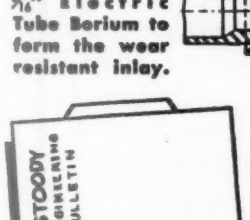

Doubles tool joint life

For fifteen years Tube Borium has been used on drilling bits to increase cutting speeds and drill more out-to-gauge hole. Now you can use this same alloy to greatly prolong the life of your tool joints!

An exceedingly small quantity of Tube Borium welded in a ring around the shoulder not only doubles tool joint life—even under the toughest operating conditions—but maintains over all joint strength and correct elevator contour. Applications are economically made on both new and resleeved joints.

APPLICATION: Accepted method of application is to under-cut new or resleeved joints at the shoulder to form a recess ⅛" deep by 1½" wide. The recess is then filled by welding in with ¾" Electric Tube Borium to form the wear resistant inlay.






Write for this special Stoody engineering bulletin describing in detail hard-facing procedures on tool joints—no obligation.

STOODY COMPANY
1142 WEST SLAUSON, WHITTIER, CALIF.

STOODY HARD-FACING ALLOYS
*Retard wear... Save Repair*


# LAUGH WITH BARNEY

Sven got into the mine elevator, chuckling out loud. "What's the joke, Sven?" asked the mine foreman. "Ay bane have good yoke on Ole," the bohunk replied. "Ay just find out Ole pay my wife five dollars to kiss her and I do it for nothing."

* * *

*Officer:* Are you happy now that you are in the Navy?
*Boot:* Yes sir.
*Officer:* What were you before you got into the Navy?
*Boot:* Much happier.

* * *

*Brenda:* I know he is the man for me, mother. Every time he takes me in his arms I can hear his heart pounding.
*Mother:* Better be careful, daughter. When your father was courting me I was fooled for a year by his dollar watch.

* * *

"Dad, what was your great ambition when you were a kid?"
"To wear long pants, son. And I've got my wish. If there's anybody in this country that wears his pants longer than I do, I'd like to see him."

* * *

*She:* You surely must enjoy your meals, you eat so much.
*He:* On the contrary I hate 'em, but I'm nuts about bicarbonate of soda.

* * *

An ancient negro was being interviewed about his religion. "Do you believe in prayer?" his employer-to-be-asked.
"Yes suh," was the reply.
"Do you say your prayers every day?"
"Yes suh, every day!"
"Does God answer all your prayers?" he was then asked.
"Yes, suh," replied the cullud one. "He answers them all—one way or anothuh!"

* * *

The customer was paying his bill at the restaurant when he noticed a dollar bill lying on the cashier's counter. "Did you know you left a dollar bill out there?" he asked.
"Oh yes," replied the cashier. "I always leave that there. I tap the counter with it anytime a customer forgets his change."

* * *

The scene was an expensive and haughtily busy night club, and it came time for one of the patrons to go. He signalled a waiter and asked: "Is it raining outside?"
"Sorry," the waiter snapped back chillily. "This isn't my table."

* * *

Boss (sending the office boy on an errand): "On the way you'll pass a baseball park."
*Boy:* "Yes, sir."
*Boss:* "Well, pass it!"

* * *

THAT WHISKEY TEST

Connect 20,000 volts across the bottle. If the current jumps it, the whiskey is poor. If the current causes a precipitation of lye, tin, arsenic and slag, the whiskey is only fair. If the liquor chases the current back into the generator, you've got good whiskey.

* * *

"You'd better jump out of the window," said the lady to her visitor, as she heard her husband approaching. "Oh yeah!" was the reply, "You know that this is the thirteenth floor, don't you?" "Well," spluttered the lady, "this is certainly no time to be superstitious."

"Science is very resourceful."
"Why?"
"It couldn't open a Pullman window, so it air-conditioned the train."

* * *

An insurance paper states that for every man 85 years old there are seven women—but it's too late then.

* * *

Zeke, the hillbilly, took unto himself a wife, and away they went to their mountain home. The first year they came down to get groceries and had a new baby with them. Coming down again the next year, they had another baby along. The third year rolled around and they showed up with the third baby. When the fourth year arrived, Zeke came down with his wife and the three children. The general storekeeper looked them over, then said: "Well, Zeke, no new child this year, huh?"
Zeke looked at him and replied with a firm nod: "Nope. Y'know—my wife and I finally found out what was causin' that."

* * *

Two American soldiers in Egypt lived for months on dehydrated beef, dehydrated milk, dehydrated butter and vegetables. Visiting a Cairo museum they saw their first mummy. "This is going too far," said one. "Now they're dehydrating women."

* * *

"Why do you pant when you read your girl's letters?"
"Because she writes so fast."

* * *

Two young wives were busily engaged in conversation at a party.
"Does your husband snore in his sleep?" asked one.
With a thoughtful look the other one answered, "I don't know, we've only been married five days."

* * *

Two old settlers, confirmed bachelors, sat in the backwoods. The conversation drifted from politics to cooking.
"I got one o' them there cookery books once, but I never could do nothing with it," said one.
"You've hit it. Every one of them recipes began in the same way—'Take a clean dish.' And that settled me."

* * *

The Tennessee boy was asking so many questions about world affairs and the chances of the democrats in the coming election that the visitor was curious.
"Don't you have any newspapers down here," he asked.
"Oh sure, we got newspapers all right, but the Republicans won't read 'em to us."

* * *

The sirens were screaming and people were racing for the shelters.
"Hurry up!" cried the housewife to her spouse.
"I can't find my teeth," called the befuddled and toothless husband.
"Teeth!" returned the exasperated wife. "What do you think they're dropping, sandwiches?"

* * *

The GI was coming home on leave after two years overseas. He cabled his parents: "Coming home shortly; prepare fatted calf; anything you want me to bring?"
The father cabled back: "Overjoyed at news. Bring fatted calf."

## Field service office

The Eastman Oil Well Survey Company announces the opening of a field service office at Brookhaven, Mississippi. Fletcher Pickens, field sales and service representative, formerly stationed at Homer, Louisiana, will supervise the Mississippi area.

## Executive assistant

Robert B. Cragin, vice president in charge of commercial development for Houdry Process Corporation, has announced the appointment of John E. Ford, Jr., of Plandome, New York, as executive assistant. Ford joins Houdry after 8 years' experience with the M. W. Kellogg Company.

J. E. Ford, Jr.

During 1941 and 1942, Ford was project engineer on the synthetic rubber plant constructed at Sarnia, Ontario, Canada. His most recent position had been that of sales engineer and executive assistant to the vice president in charge of sales.

Ford began his experience in the petroleum field after his graduation from Georgia School of Technology where he received his bachelor degree in chemical engineering. His early experience included service in the technical department of the Sinclair Refining Company at Houston, Texas.

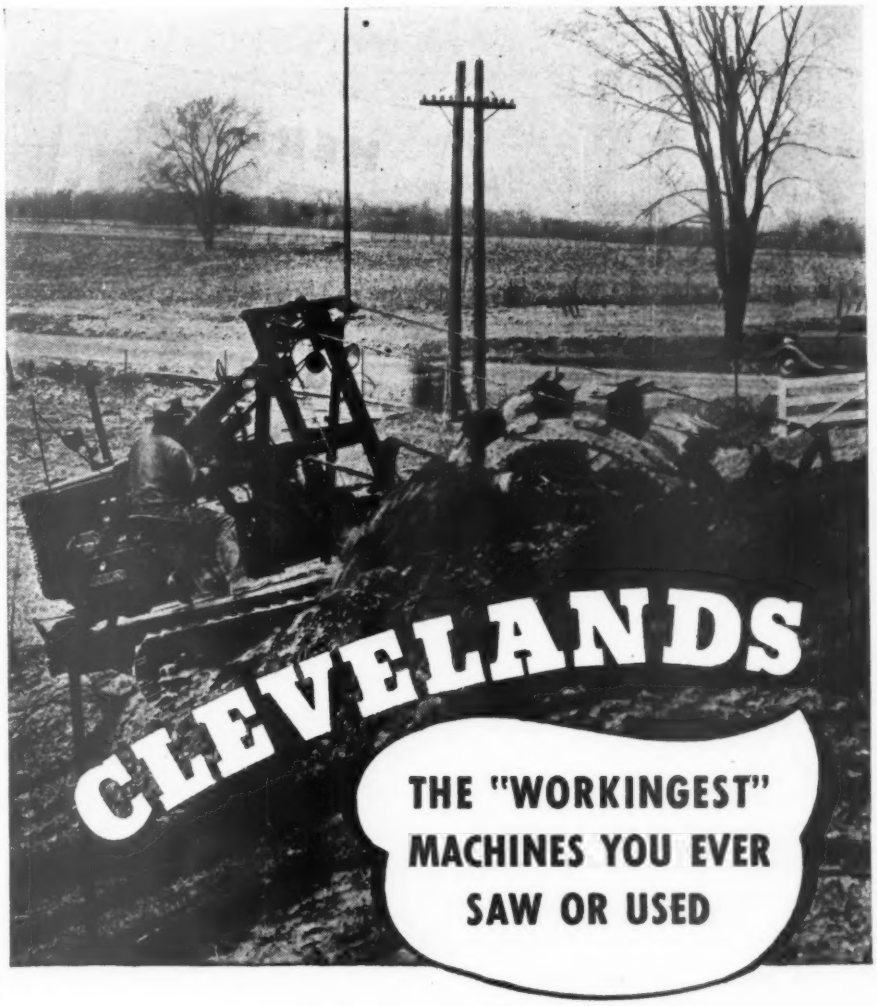
## Nomads whing ding

The low, dense haze that hung over the Riviera Country Club in Los Angeles on Friday afternoon, July 27, rendering visibility zero or a very creditable imitation thereof, was not the result of a Japanese attack as was at first supposed. Closer inspection revealed the fact that the cloud sprang from countless bunkers in which entrapped and enraged equipment salesmen cried softly while they belabored the sand in an agony of frustration. The highly emotional character of this strange Nomadic rite—an annual performance is exaggerated terrifically by the topography of the chosen site.

This Riviera Club course was obviously laid out by someone with a hangnail. It is long, crooked and unkind. The way from the driving tee to the putting green in every case is a narrow and devious route, strewn liberally with booby traps and obviously designed to promote an easy and copious flow of vituperation. Even people of kindly disposition, like Pete Maxfield, Harold Howard, Bob Lytle, and Ernie Adams have to fight a rising inclination to chew pieces out of their Panama hats, as they carve their respective ways out of one hellish device only to find themselves in another.

All of which is preliminary to the announcement that one of the highlights of the Nomad's Whing Ding was a golf tournament in which about 140 otherwise perfectly sane individuals went on Safari. Some new territory was excavated and annexed to Los Angeles County, and from all other angles the expedition was completely successful. Awarded top honors in the distinctly haphazard enterprise were Ray Pilson of Phelps Dodge and Al Randolph of Century Oil. Others who excelled in this abstruse branch of the agricultural arts were Ross Chambers of Shell Oil Company; Glen Johnson, Baash-Ross; Ted Jurling, Byron-Jackson, and Earle Boggess of Baker Oil Tools. Special commendation should also be given, of course, to George Trembley who managed the affair in a brace of multi-colored shirts that must have been painted by the camouflage division of the marines.

Altogether some 400 Nomads and friends spent the better part of a day disporting or relaxing at the Whing Ding and thanks to Prexy Elmer Smith, Hi Cassidy, Fred Tyler, Jim Robinson, Wally Sawdon, and their aides, a nice time was had by all. After a good dinner in the evening, Wally Sawdon presented a vaudeville show that was quite up to all the advance notices. In fact, from the opening bell until curfew sounded about midnight, there wasn't a minute that wasn't thoroughly enjoyable.


CLEVELANDS . . . Modern, dependable, rugged and fast—represent the highest development in the full-crawler, wheel type trencher, pioneered by "Cleveland" more than twenty years ago.

A wide range and combination of digging and travel speeds, ample power for the toughest going in all kinds of soil and terrain, ease of handling, low fuel and operating costs and minimum times out for repairs, are some of the many practical advantages characteristic of Clevelands that assure you most completed trench at least cost on all your trenching jobs.

THE CLEVELAND TRENCHER COMPANY
20100 ST. CLAIR AVE. • CLEVELAND 17, OHIO
"CLEVELANDS" Save More . . . Because They Do More

## To direct AGA

H. Carl Wolf, president of the Atlanta Gas Light Company, Atlanta, Georgia, has been elected managing director of the American Gas Association, effective October 1, 1945, it is announced by J. French Robinson, president of the association. Wolf will succeed Alexander Forward, managing director since 1923, who is retiring from active business.

Wolf was born in Edwardsville, Illinois, and graduated from the University of Illinois, having earned both his bachelor's and master's degrees in electrical engineering. He entered the utilities field as assistant engineer for the Illinois Commerce Commission and later became manager of the Edwardsville, Illinois, Water Company. In World War I, he was a captain in the United States Engineer Corps, serving 18 months in France as a combat engineer and with the American Peace Commission.

From 1922 to 1929, Wolf was chief engineer of the Public Service Commission of Maryland. He became assistant to the president of the Central Public Service Corporation and later was elected vice president of Consolidated Electric and Gas Company and then president of the Central Indiana Gas Company and its associated companies.

Wolf was elected president of the Atlanta Gas Light Company in 1938.

## Coast representative

W. H. Larkin, president, Larkin Packer Company, announces the recent appointment of Howard Supply Company in Los Angeles to represent Larkin products on the West Coast. The complete line of Larkin float equipment and tubing heads will be carried in Howard Supply Company's Los Angeles warehouse and a representative stock carried in each of the distributor's 9 field stores.

Larkin's appointment of Howard Supply Company on the West Coast is a part of the manufacturer's present program of expansion toward a more thorough distribution, particularly of such cementing equipment as the "Perfect Circle" shoe and the "Cementrol" shoe.

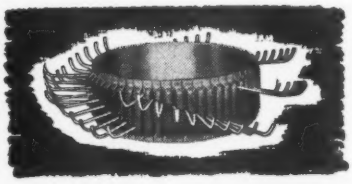
## Joins Crocker-Wheeler

Charles A. Butcher, formerly manager of the Pacific Coast manufacturing and repair department of the Westinghouse Electric Corporation, Oakland, California, has been appointed assistant general manager of the Crocker-Wheeler division, Joshua Hendy Iron Works, Ampere, New Jersey.

C. A. Butcher

After his early electrical experience with the Des Moines City Railway Company, he joined Westinghouse and was employed, successively, in Chicago district sales, East Pittsburgh design engineering and general engineering. Subsequently, Butcher held the following positions with Westinghouse: Eastern district engineering manager and eastern district service manager, New York City; manager of eastern manufacturing and repair department at Newark, New Jersey; assistant manager of manufacturing and repair department, East Pittsburgh, and manager of Pacific Coast manufacturing and repair department, the latter just previous to his joining Crocker-Wheeler.

A CLEAN HOLE, allowing the cement to bond with the formation: casing centered in the hole, so the cement makes a wall of uniform thickness — these two factors insure a perfect cement job. And B & W Wall Cleaning Guides in sufficient number, properly spaced on the casing, give you **both.** As you move the casing while cementing, the spring-steel fingers clear the wall of mud cake and keep the casing centered. Result — a permanent, fluid-tight sheath of cement — no weak spots, no channeling, no fluid migration, no salt water. **No expensive re-cementing.**



B and W INCORPORATED

BRUCE BARKIS • KENNETH WRIGHT

*Well Completion Specialists*

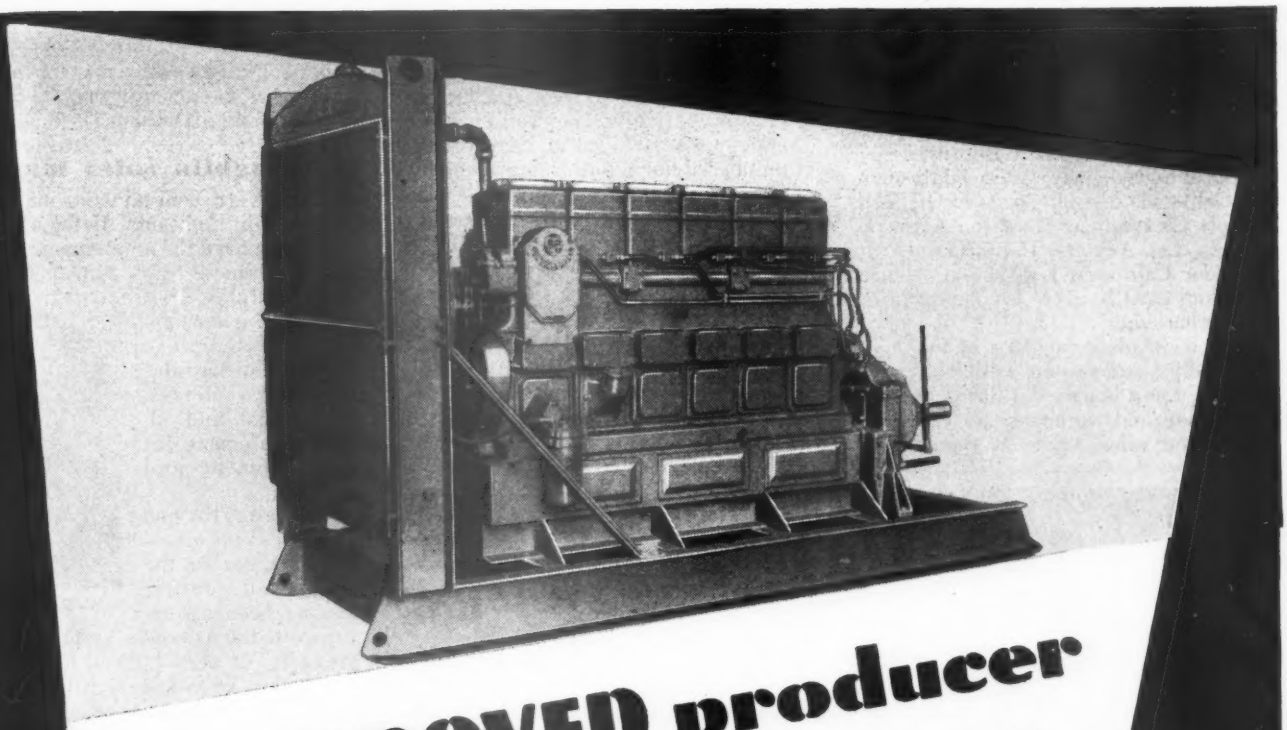
WEST COAST: 3545 Cedar Avenue
Long Beach, Calif. • Phone: L.B. 4-8306
GULF COAST: 305 M&M Building
Houston, Texas • Phone: Preston 9783

**MECHANICAL ENGINEERS**

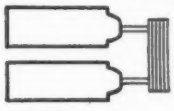
Experienced in oil tools, pumps, rigs, and drilling equipment.

Must have successful prewar background. Permanent position with large, progressive organization. In replying give full particulars, places worked, projects, etc.

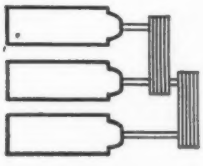
Institute of Product Research Dept. LAH-448 South Hill Street, Los Angeles 13, California.



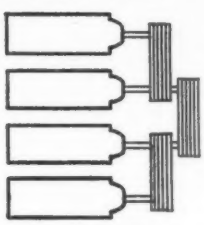
# The PROVED producer of low-cost footage



*450 hp.:* The first rigs powered with compounded Cummins Diesels used *two* Model LP-600's, each rated at 225 hp. at at 800 rpm., producing a total of 450 hp.



*675 hp.:* Prompted by the success of the two-engine hook-up and also by the trend toward deeper drilling, rig builders fashioned their designs around *three* compounded Model L's which provide a total horsepower output of 675 hp.



*900 hp.:* Visualizing "deep hole" drilling on an increased scale, manufacturers now have in production rigs which call for *four* compounded L's on the drawworks and two L's compounded on the mud pump.

n choosing the power for your new rig, make sure that you get a *proved* producer of low-cost footage. That Cummins Diesel power is such a producer—a producer of *faster, cheaper* footage—has been demonstrated by its 12-year performance record in every major field and in every heavy-duty oil field service. As a result of that record, Cummins Dependable Diesels are now standard with successful drilling contractors everywhere . . . are offered as original power by leading rig manufacturers . . . power more rigs in the great Mid-Continent Area than any other diesel.

CUMMINS ENGINE COMPANY, INC., Columbus, Ind.

CUMMINS DIESELS

SINCE 1919...PIONEER OF PROFITABLE POWER THROUGH HIGH SPEED DIESELS

## Buys Neilsen Pump

Oil Well Supply Company, United States Steel Corporation subsidiary, has announced its intention of exercising an option for purchase of the assets of Neilsen Pump Company of California.

The announcement was issued through the California division offices of Oil Well Supply Company at Main and Alameda Streets, Los Angeles, California.

Under California law, notice of such intention must be recorded 7 days prior to purchase date.

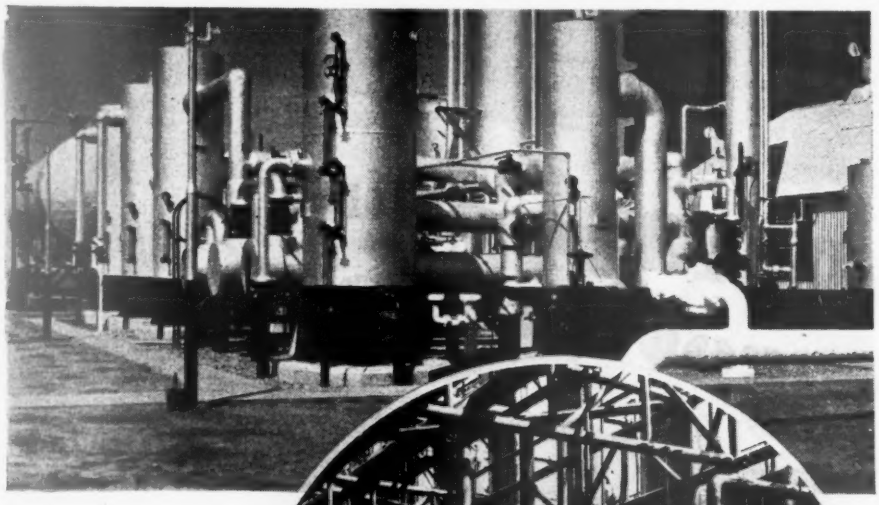
The main plant facilities of the Neilsen Pump Company are at 3204 Cherry Avenue, Long Beach, California; with a large shop and warehouse at Taft, and stores and sales offices at Bakersfield, Huntington Beach, and Ventura.

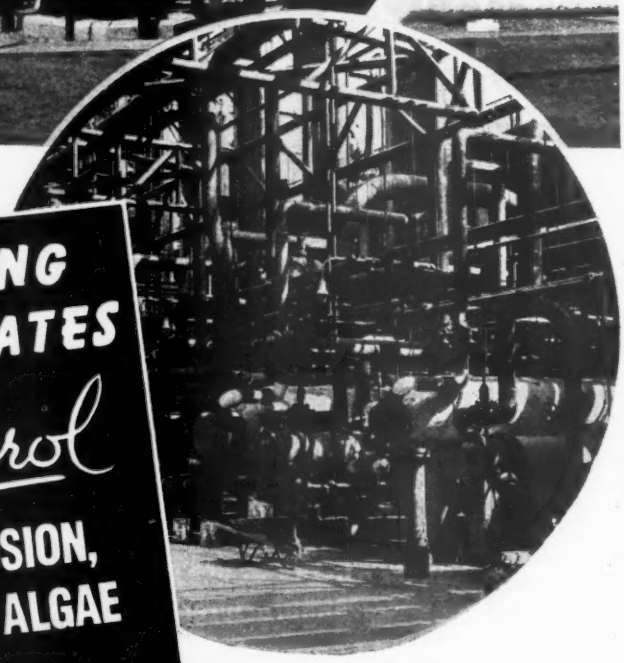
The company, long established factor in California oil production circles, is owned by Karl P. Neilsen and Edward D. Storts, partners. The Neilsen Pump Company was founded in 1926. In 1941 it purchased the Alford Pump Company.

Under the projected purchase plan, the company's assets will be organized into what will be known as the Neilsen Pump Division of Oil Well Supply Company. It manufactures a line of subsurface pumps and accessories.

This acquisition will establish Oil Well Supply Company as a California manufacturer of oil field materials.

"No significant changes in personnel or establishment are contemplated," Albert R. Zelt, vice president, Oil Well Supply Company, Dallas, said. He said Karl P. Neilsen will remain with the organizaton as general manager of the Neilsen Pump Division.



HAERING GLUCOSATES *control* CORROSION, SCALE, ALGAE in the PETROLEUM INDUSTRY

Write on your letterhead for "ECONOMICS OF WATER CONDITIONING"

WE READ WATER

D. W. HAERING & CO., Inc.

GENERAL OFFICES:

205 West Wacker Drive, Chicago 6, Ill.


## McLaughlin sales manager

A. J. Kerr, general sales manager of Pittsburgh Equitable Meter Company, has announced the appointment of W. R. McLaughlin as sales manager for the gas products division. In his now position McLaughlin will direct the sales for Emco meters, regulators, and allied equipment for measurement and control.

W. R. McLaughlin

McLaughlin has spent his entire business career in the gas and oil industry, having been associated with the Arkansas Natural Gas Company for a period from 1919 through 1934 when he joined the Pittsburgh concern as a sales engineer.

While connected with the Arkansas Natural Gas Company his work was largely devoted to gas distribution, pipe line, and transmission activities that involved measurement and regulation. In 1928 he was made superintendent of the gas measurement division for this utility.

McLaughlin is well-known for his work in furthering the interests of the Southwestern Gas Measurement Short Course, which is held annually at the University of Oklahoma, Norman, Oklahoma. He has served on numerous committees throughout the 22-year tenure of this school and was general chairman in 1934. He has also served at various times on the gas meter committee of the American Gas Association, and the gas measurement committee of the American Petroleum Institute.

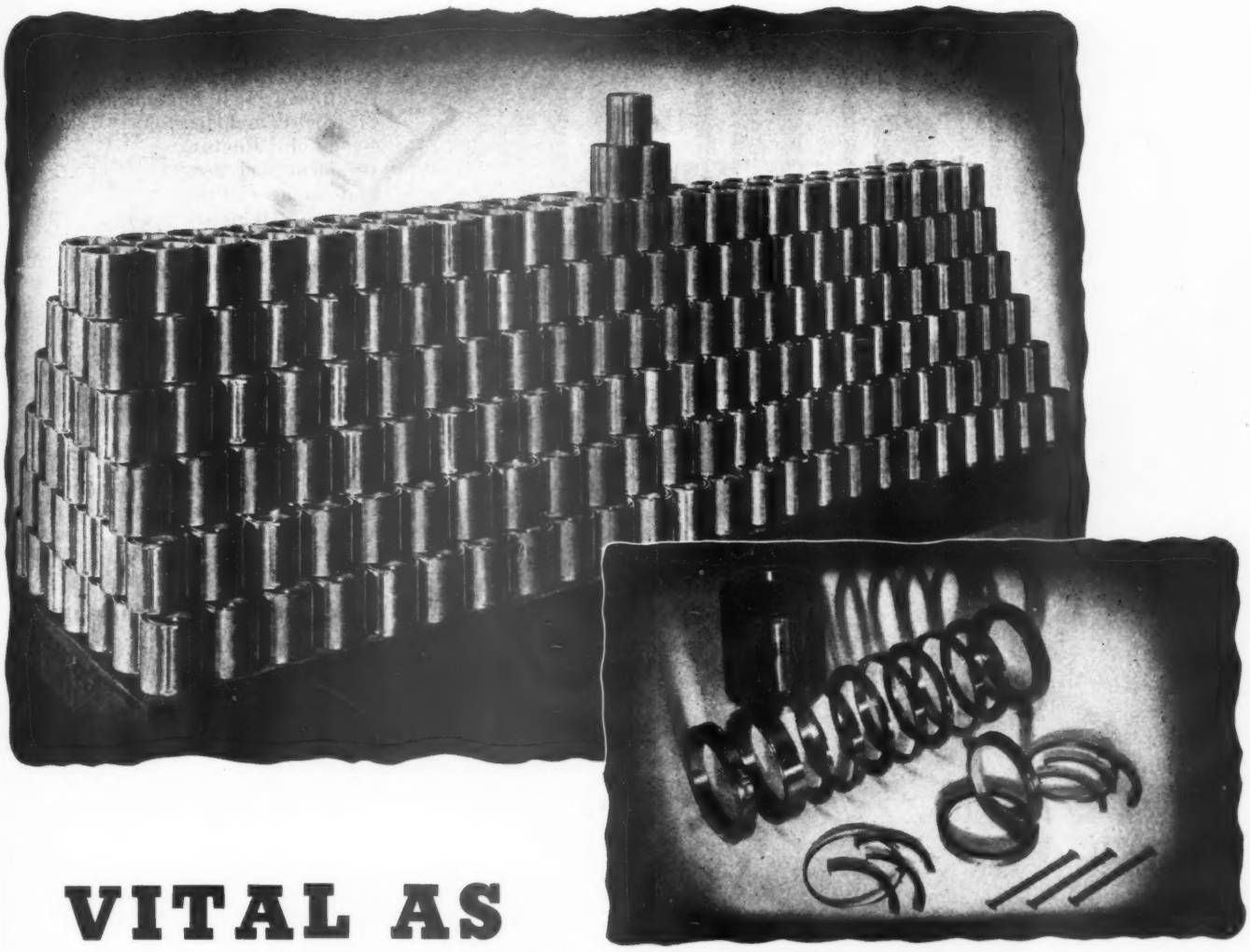
He was one of a committee of eight selected from industry to assist the faculty of the Texas College of Arts and Industries, Kingsville, Texas, in establishing a course in natural gas engineering. For this participation he was awarded an honorary degree in natural gas engineering by the college in 1938.

## New Kerotest warehouse

As a means of improving its methods of distribution in the Pacific Coast area, Kerotest Manufacturing Company, Pittsburgh valves and fittings manufacturer, announces the establishment of a new warehouse at 3311 East Slauson Avenue in Los Angeles, with J. A. Swaton as district manager for steel valves and J. A. Norris as district manager, brass division.

Swaton, with Kerotest for more than 20 years, and Norris will maintain headquarters in the new warehouse and the latter will coordinate all activities throughout the entire Pacific Coast area.

Van D. Clothier will continue as the southern California representative for brass valves with headquarters at 1015 East 16th Street, Los Angeles, California.



# VITAL AS ARTILLERY SHELLS!

PACKINGS empower ships to move and industry to produce the implements of war. . . . For without packings no steam engine, no Diesel, no gas engine and no compressor could function. . . . From this fact it can be understood that wartime's demands for packings have been vast and urgent. . . . In meeting them, COOK'S Metallic Packings have played a major role. . . . Month after month they have poured out in a steady stream to equipment manufacturers, to shipyards, chemical plants, steel mills, oil and gas fields and industry in general—standard COOK'S Packings by the thousands—and many special designs, engineered to meet new service conditions. . . . One such special service packing is illustrated, with a typical month's production. . . . The satisfaction of contributing so materially to the war effort has been marred by one thing only—the impossibility at times of promptly filling the needs of some of our old and valued customers. . . . For their understanding patience and patriotic spirit of cooperation, we sincerely thank these customers—and assure them that, while continuing the war job still to be done, we are doing everything possible to restore the prompt shipment on all orders and immediate shipment in emergencies that has always distinguished COOK service.

*COOK'S GRAPHITIC IRON PISTON RINGS too, are playing a big part in the war effort on land and sea.*

Sealing Pressures Since 1888

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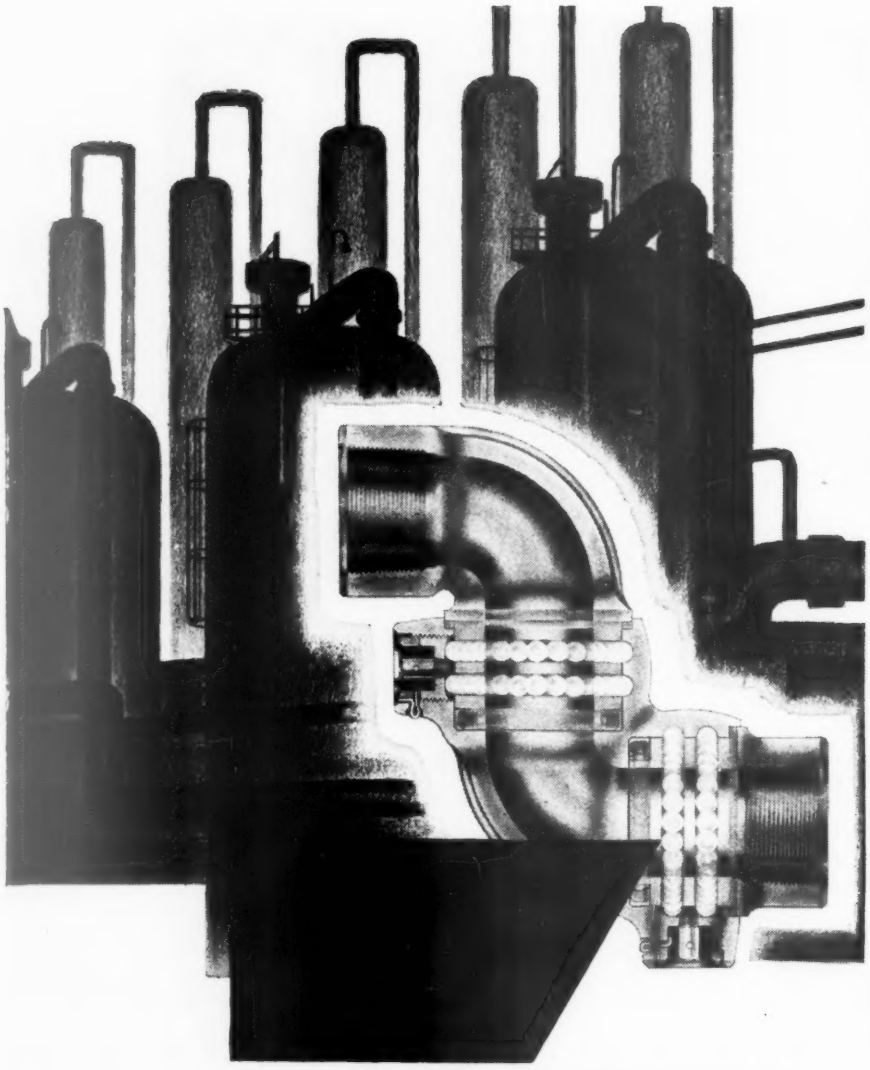

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**for perfect flexibility meets every demand of industry**

CHIKSAN **BALL-BEARING** Swivels got their start and built their reputation for perfect flexibility in the Petroleum Industry. As this Industry became more and more important as a vital source of materials for the manufacture of synthetic products, Chiksan Swivels have proved their adaptability to every need . . . wherever flexibility is required . . . on lines handling steams, acids, alkalies, chemical compounds, gas, gasoline, etc. Many new applications have been developed to speed up production for war and for peace. There are over 500 different Types, Styles and Sizes of Chiksan Swivels. Tell us your requirements and we'll be glad to suggest those best suited to your specific needs.

*REPRESENTATIVES IN PRINCIPAL CITIES*

**$BB_2$ = Double Rows of Ball Bearings**
**EP = Effective Packing Element**
**P/V = Pressure or Vacuum**
**LT = Low Torque under all conditions**

CHIKSAN TRADE MARK REG.
BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES
CHIKSAN COMPANY
BREA, CALIFORNIA

## Rector names Atkins

The appointment of Earle R. "Pop" Atkins as California representative for the Rector Well Equipment Company, Fort Worth and Houston, Texas, is made by L. L. Rector, president and general manager of the company. Atkins has offices in the W. W. Wilson Building, Huntington Park, California. Among the products manufactured by the company are the well known Rector well heads and Rector-seal. Sales policies as established by the company in the Texas and Mid-Continent fields will be maintained by Atkins in industrial sales, as well as the sale of oil field equipment.

Earle R. Atkins

## Modernization program

"Pacific Coast users of sheet and tin plates may expect even better service from Columbia Steel Company after the war as a result of the further step in Columbia's modernization program announced by U. S. Steel." William A. Ross, president of U. S. Steel's West Coast subsidiary, said.

"The authorization of the installation at Columbia's plant at Pittsburg, California, of modern cold reduction facilities of an annual capacity of more than 325,000 tons of sheet and tin plate is a continuation of the modernization program that was inaugurated shortly after Columbia became a part of U. S. Steel in 1930. Until interrupted by the war, Columbia had expended large sums for such modernization. This program, from its inception, has embraced the installation of modern cold reduction facilities to enable Columbia to supply its customers with cold reduced sheet and tin plates of the highest quality. Erection of the finishing facilities near the market will assure customers of prompt delivery and efficient service."

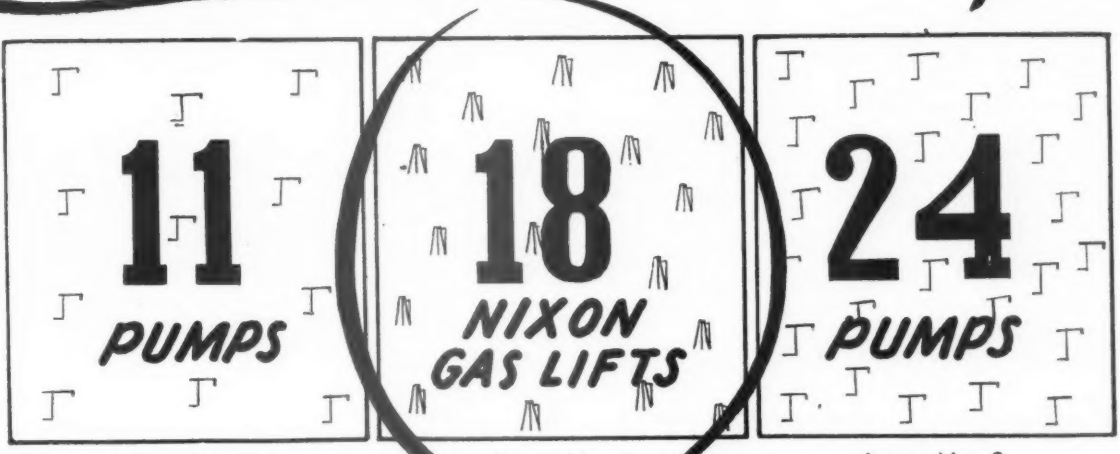
## Meter meeting

C. H. Van Marter, training and safety representative of the Union Oil Company of California, presented his "Table Top Demonstration of Basic Fire Facts" at the August meeting of the Southern California Meter Association.

As usual, the meeting was held at the Rio Hondo Country Club, Downey, California, on August 16.

Stanley D. Clithero, assistant engineer, fire prevention and control department, General Petroleum Corporation, presented a motion picture, "Fighting Oil Fires." The film showed the fundamentals of combustion and the combustion characteristics of various fuels. It also illustrated the character of fire extinguishing apparatus. The film showed fire fighting technique and included Chicago Fire School film on the fighting of real fires.

# Compare these Production Figures




Lease No. 2 | Lease No. 1 | Lease No. 3

**Lease 1** Average daily pipe line runs on 18 Nixon Gas Lifts . . . 145 bbls. . . . 8 bbls. per day—per well.

**Lease 2** Average daily pipe line runs on 11 offset pumps . . . 23 bbl. . . . 2.1 bbls. per day—per well.

**Lease 3** Average daily pipe line runs on 24 offset pumps . . . 34 bbls. . . . 1.4 bbls. per day—per well.

The Nixons on this West Texas lease were installed five years ago — and on many of them tubing has never been pulled. Maximum oil recovery plus low maintenance costs — mean greater profits to the producer. Investigate the Nixon Surface Control Gas Lift System today.

*"The Modern Way . . . of Lifting Fluid"*

## Export corporation formed

Colonel W. F. Rockwell, president of Pittsburgh Equitable Meter Company, Pittsburgh, Pennsylvania, has announced the formation of the Pittsburgh International Corporation, with offices at 7701 Empire State Building, New York City. This firm will handle the export sale and distribution of products manufactured by Pittsburgh Equitable Meter Company-Merco Nordstrom Valve Company, and subsidiaries.

The Pittsburgh International Corporation will be under the direction of A. L. DiGiulian, vice president. DiGiulian has had extensive experience in foreign markets. He was educated in Europe, completing studies in Italy, Spain, and Portugal. He was graduated from Georgetown University, School of Foreign Service, in 1927, and has since been honored by the university with a special certificate for his accomplishments in foreign service and with the Coutinho medal for his work in the Portuguese language. DiGiulian, who is an accomplished linguist, has spent many years in U. S. Government service. His immediate connection prior to accepting his new post was Chief, Foreign Communications Section, Office of Exports, Foreign Economic Administration, Washington, D. C.

DiGiulian will be assisted in the operation of the export firm by George E. Doty. Doty, after attending Carnegie Institute of Technology, joined the Pittsburgh Equitable Meter Company in 1926. His experience embraces all phases of manufacture and sale of the company's products. Prior to war he served as export manager. More recently Doty was assigned to the Merco Nordstrom Valve division at the Oakland, California, plant, as assistant to the general manager.

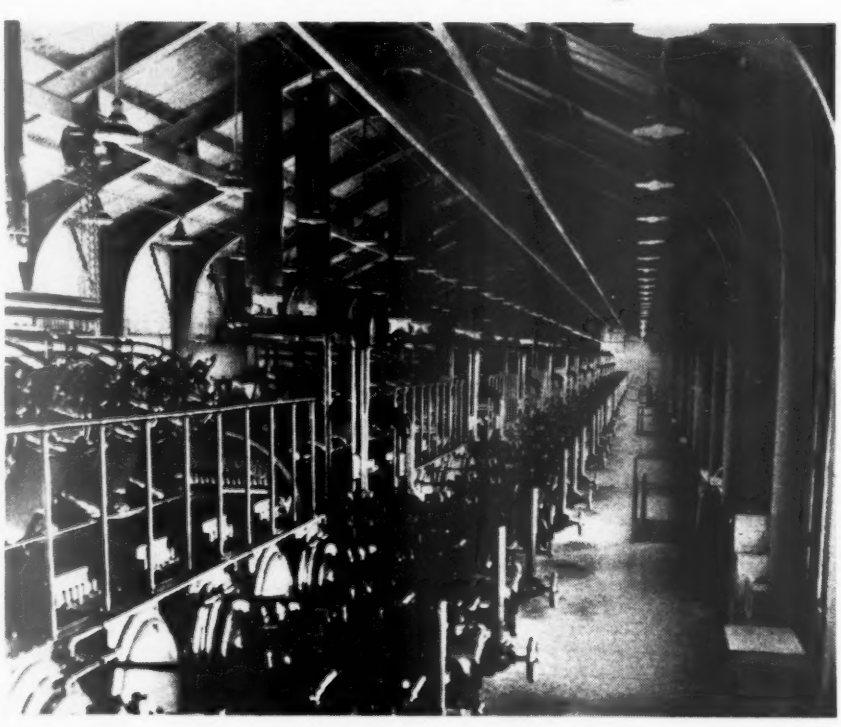
The New York offices of the Pittsburgh International Corporation will be opened September 1.

## Heads Byers sales

Robert H. Gardner has been appointed general manager of sales of A. M. Byers Company, President L. F. Rains announces. Gardner has been manager of Byers' Washington office since 1933, except for a four-year period ending in 1940 during which he was manager of the company's steel pipe sales, with headquarters in Pittsburgh. He takes over the duties of the late Myron J. Czarniecki, who died June 18. Prior to going with Byers, Gardner was assistant sales manager of Caterpillar Tractor Company.

At the same time, the appointment of H. B. Rowland as assistant general manager of sales was announced. Rowland joined the company's sales department in 1915. In 1925 he became manager of the Pittsburgh division, and in 1944 was named manager of hot rolled sales.


# Braden's Modern Arch Welded Design



This type building permits the use of lower sidewalls because the trolley beams can be supported directly from the arches.

Unobstructed interiors and larger lighting areas result when Braden's Welded Arch Type construction is used.

*Estimates Furnished*

**BRADEN *Steel* BUILDINGS**

**BRADEN STEEL CORPORATION**

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**Branch Offices:** Houston and Dallas, Texas, and Cleveland, Miss.
**Representatives:** Kansas City, Mo.; Amarillo, Tex.; Wichita, Kan.; Odessa, Tex.; Oklahoma City, Okla.
**Export Agent:** Russell D. Heath, Room 605, 125 Barclay St., New York 7, N. Y.



*"Best Bet Yet"*

These oil-proof, wear-resistant, plastic tubing protectors are an integral part of the tubing collar. Made in all sizes, they prevent the metal-to-metal contact that has caused many expensive "wet" jobs in pumping wells in the past.

**PATTERSON-BALLAGH TUBING PROTECTORS**

LOS ANGELES 1 • HOUSTON 10 • NEW YORK 6

## Rejoins Reliance

J. E. Gesner recently rejoined Reliance Regulator Corporation, division of American Meter Company, as engineer.

His experience includes 15 years with the Pacific Gas and Electric Company, where he started in the East Bay division, from which he was advanced to the Colgate division as measurement inspector. He later became industrial gas engineer of the general sales department.

Gesner's scholastic background includes Polytechnic College of Engineering, Oakland, California, and the University of California.

## Handles Vickers' pump

The Houston Oil Field Material Company, Inc., is again selling and servicing the Vickers' hydraulic pump. The manufacture of this pump, which has a outstanding service record in lifting sand-contaminated fluid, was discontinued shortly after Pearl Harbor due to the shortage of critical materials. Rather than make a pump with inferior steels, the Vickers Company discontinued this product; however, the high alloy steel used in its manufacture is now available and large pump stocks are now maintained in Homco stores.

The Houston Oil Field Material Company is the sole Mid-Continent distributor for the hydraulic pump. J. A. "Cat" Watson, who has supervised the sales and service of this pump for many years, is again back in the field performing similar tasks for Homco.

The Vickers hydraulic pump is of the displacement type, embodying a by-pass arrangement that tends to prevent sand cutting, as well as sanding-up of the working mechanism.

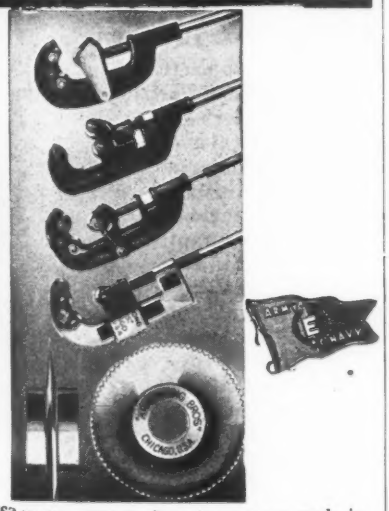
## New magazine

*The Humble Way*, new publication of the Humble Oil and Refining Company, Houston, Texas, makes its first appearance with the May-June issue. The magazine is designed to give Humble employes, stockholders, and others a better knowledge and understanding of the work Humble people are doing, how they are doing it, and the progress they are making, says an editorial introducing the publication to its readers. Further, the introduction states:

"The scope of the magazine will be broadened to include material relating to affairs of the petroleum industry generally as well as to company affairs. Humble people, located as they are from New Mexico to Florida and all the states in between, are interested in knowing more about each other, how they live and how they work. This magazine, it is hoped, will form a connecting link between these widespread groups and with the home office, drawing all these elements closer together with the bonds of knowledge and understanding."


Look for the Arm-and-Hammer

ARMSTRONG BROS.



ARMSTRONG BROS. Pipe Cutters are made in all standard types. Each is a quality tool with hardened steel pins and rollers. "Saunders Type"—hardened end of thrust rod bears on inserted hard steel block (double life). In "Drop Forged" and "Combination" types, which take either 1 or 3 wheels, a replaceable hardened steel nut takes up thrust. In the "Barnes" type thrust rod threads through drop forged steel section.

ARMSTRONG BROS. Knife Blade Cutter Wheels (smooth or knurled) have thin penetrating edges that hold their keenness because they are machined from special vanadium tool steel, hardened and oil tempered. Fit all standard-make pipe cutters. . . . *Write for Catalog.*

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"The Tool Holder People"
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SAFE from Cold, Moisture, Dust and Corrosive Gases.
MACNICK CHART CLOCKS are hermetically sealed, protected against all enemies; uninterrupted service is assured, and repair costs are lowered to almost zero. These clocks fit practically all instruments using circular charts, thus enabling you to reduce your clock inventory to the minimum. Thousands in use by major companies.
MACNICK CHART CLOCK
10 ROTATION SPEEDS! Interchangeable Converter Gears effect one turn of the chart in 2, 3, 4, 6, 8, 12, or 24 hours, or in 2, 3, or 7 days, $3.50 each. 10 accurate rotation speeds with ONE CLOCK!
$9.50 EACH
For the 24-Hour Clock, Complete with Adapter & Winding Key.
SEND FOR BULLETIN NO. 104-A
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RECORDING CHART CO.
3113 E. 11th St. Los Angeles 23, California
SEND FOR COMPLETE LIST OF ARCCO CHARTS

## Heads Brown Instrument

Election of Henry F. Dever as president of the Brown Instrument Company, a wholly-owned subsidiary of the Minneapolis-Honeywell Regulator Company, is announced by Harold W. Sweatt, president of the parent company.

Dever, who has been serving as vice president in charge of engineering for Minneapolis-Honeywell, succeeds Charles B. Sweatt as president of Brown. The latter, vice president and director of Minneapolis-Honeywell, has withdrawn from Brown and will henceforth devote his entire attention to supervision of the expanded sales activities of the Honeywell organization and its subsidiaries.

Dever will also assume the responsibilities of E. B. Evleth, general manager of Brown Instrument, who, because of ill health, has requested that he be relieved of his duties at an early date.

Engineering activities of the parent company will be under the direction of W. J. McGoldrick who has been vice president in charge of aeronautical engineering, it was stated. Under McGoldrick will be consolidated the company's engineering activities in the domestic and industrial heating and air conditioning controls field, and the operation of the aeronautical engineering department, which developed the electronic Autopilot and other aircraft equipment for the Army Air Forces.

A graduate of Northwestern University, where he received degrees of bachelor of science and electrical engineering, Dever joined Honeywell as a sales engineer in 1931, Sweatt said. He was formerly employed by the Underwriters Laboratories in Chicago, the Absolute Con-Tac-Tor Corporation of Elkhart, Indiana, and the Time-O-Stat Company. Both of the latter companies were merged with Minneapolis-Honeywell in 1931. In 1936 Dever was appointed branch manager in Philadelphia and was made vice president in charge of engineering in 1939. He is a member of the American Society of Heating and Ventilating Engineers.

Yes sir! AMERICAN HEAVY DUTY ROLLER BEARINGS are made to take all you can give them—and more! Put them to the most abusive, gruelling service you can think of . . . in the heaviest, most powerful equipment built . . . and they'll carry the load smoothly and easily, with minimum maintenance for maximum periods, often outlasting the equipment itself. No wonder AMERICAN HEAVY DUTY ROLLER BEARINGS are specified by most major manufacturers and designers of heavy industrial machinery.

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*Pacific Coast Office:* 1718 S. Flower St., Los Angeles, Calif.

AMERICAN ROLLER BEARINGS HEAVY DUTY

**AMERICAN**
*Heavy-Duty* ROLLER BEARINGS


## In charge engineering

Harry A. Feldbush, formerly works manager of the Holyoke, Massachusetts, plant of Worthington Pump and Machinery Corporation has been named vice president in charge of engineering for the entire corporation. His duties cover engineering activities of all works and domestic subsidiary companies. His headquarters will be at the general offices in Harrison, New Jersey.

Harry A. Feldbush

Ralph M. Watson, formerly chief engineer of the centrifugal engineering division, has been appointed assistant to Feldbush.

## Pump distributors

Uhrich Supply Company of North Kansas City, Missouri, has been appointed distributors of Peerless vertical and horizontal pumps in the Kansas-Missouri area by Peerless Pump division of Food Machinery Corporation. C. H. Pratt is manager of the Uhrich organization. Uhrich succeeds Butters Equipment and Supply Company, which is retiring from business.

C. H. Pratt


GRADUATE GEOLOGIST for foreign exploration; at least three years experience in field geological mapping, preferably in Rocky Mountains or in South America.

FIELD GEOPHYSICIST to supervise contract geophysical parties in eastern Venezuela; seismograph party chief experience desirable.

WELL GEOLOGIST (Foreign) to watch geologic progress of wells, care for samples, pick casing points, etc. Paleontological training, experience in well progress geology desirable.

Major oil company. Apply P. O. Box 2819, Dallas, Texas.

DEAN BROTHERS PUMPS INC.
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PUMPING MACHINERY

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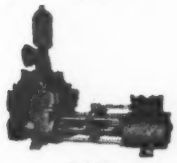
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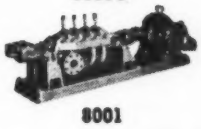
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BRANCH OFFICES
NEW YORK HOUSTON CHICAGO

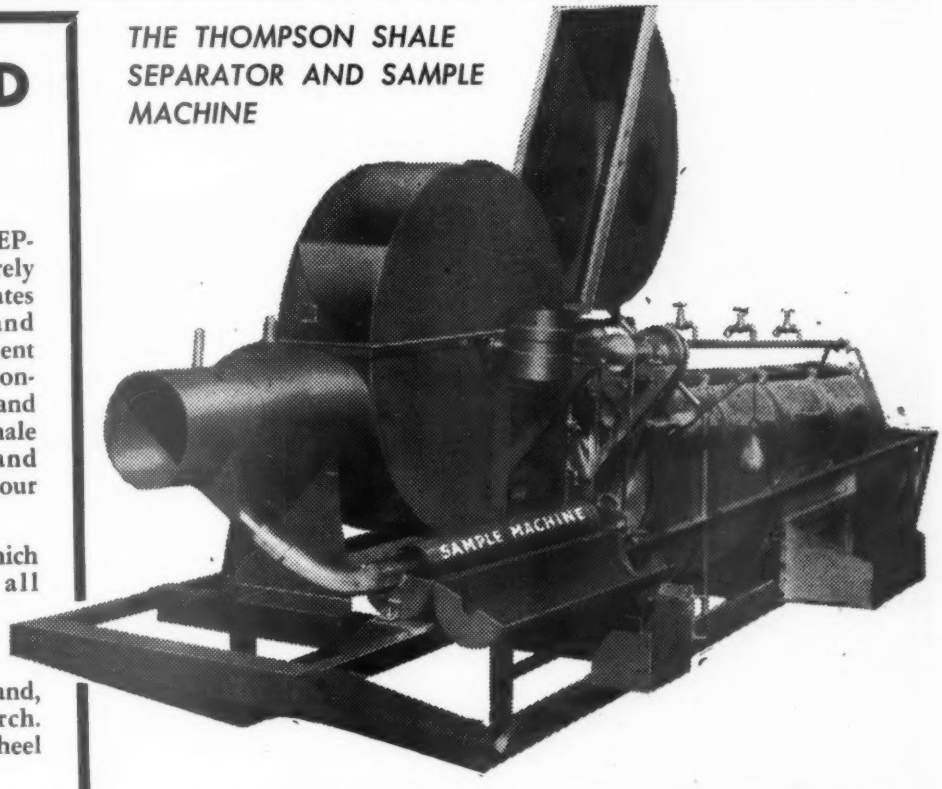
# KEEPS MUD CLEAN!

THE THOMPSON SHALE SEPARATOR, which operates entirely from the flow of mud, eliminates destructive abrasives, saves and protects critical drilling equipment and materials. This machine is considered the most economical and simplest method of removing shale from mud while drilling, and should be a standard part of your modern drilling equipment.

THE SAMPLE MACHINE, which is standard equipment on all Thompson Separators, unless otherwise specified, is a test proven method of securing true samples of cuttings and sand, valuable in geological research. Operates from main power wheel of the separator.

This machine represents only a very small investment and will pay for itself in savings alone within a very short time!

THE THOMPSON SHALE SEPARATOR AND SAMPLE MACHINE




THOMPSON TOOL CO.

IOWA PARK, TEXAS, U.S.A.

## Regroups staff

As part of the preparations of Standard Oil Company (Indiana) for postwar activities, a regrouping of its research and development staff is announced by Bruce K. Brown, vice president. The changes follow on Brown's recent re-election as a director and elevation to a vice presidency and on the promotion of Joseph K. Roberts to the position of general manager of research.

B. K. Brown

In order to coordinate the research work more closely with that of other departments, two associate research directors have been moved from the Whiting, Indiana, laboratories to the general office in Chicago. Although continuing his technical assignments, D. P. Barnard will also undertake liaison with the sales department with the aim of ensuring that the programs in reseach are consistent with consumer demands and needs and with the present and future trends in automotive and aircraft developments. Dr. Barnard is at present in Europe on an investigation sponsored by the Army Air Force. J. H. Forrester will also move to Chicago as general supervisor of technical service and product inspection activities for all refineries.

At the Whiting laboratories M. T. Carpenter has been appointed to the new position of executive director. A graduate of the University of Kentucky, he has been with the company for 15 years and had been an associate director of research since 1938.

R. C. Gunness has been raised from the rank of assistant director to that of associate director. Dr. Gunness received his doctor's degree from Massachusetts Institute of Technology in 1936, and spent 2 years on the faculty as a director in the school of engineering practice before joining Indiana's research staff.

J. K. Roberts

M. T. Carpenter

R. N. Giles

R. C. Gunness

R. N. Giles, also an assistant director, has been promoted to the new position of superintendent of the technical service division. After graduate work at Ohio State in 1930, Dr. Giles spent 4 years at the company's Casper, Wyoming, refinery and was then moved to the research staff at Whiting.

A. B. Brown has become assistant superintendent in charge of technical service on heavy oils. He has been with Standard Oil since receiving his Ph.D. at Johns Hopkins.

C. R. Harte has been made assistant superintendent in charge of the work on light oils technical service and will also continue to supervise economic studies. After graduate work at Michigan and several years of subsequent experience in industry Dr. Harte joined the Indiana staff in 1936.

The two new heads of Standard's research and development activities arrived at their high positions through training and experience in chemistry and chemical engineering. Brown did undergraduate and graduate work at the University of Illinois. After 9 years' industrial experience as a chemical engineer and patent attorney he joined the Indiana company's staff in 1929. From 1942 to 1944 he had leave of absence to serve the government as assistant deputy petroleum coordinator. Roberts was graduated from the University of Kentucky in 1925, received a master's degree in chemical engineering from M.I.T. in 1928, and has since been on the S. O. research staff. He became director of research in 1938.

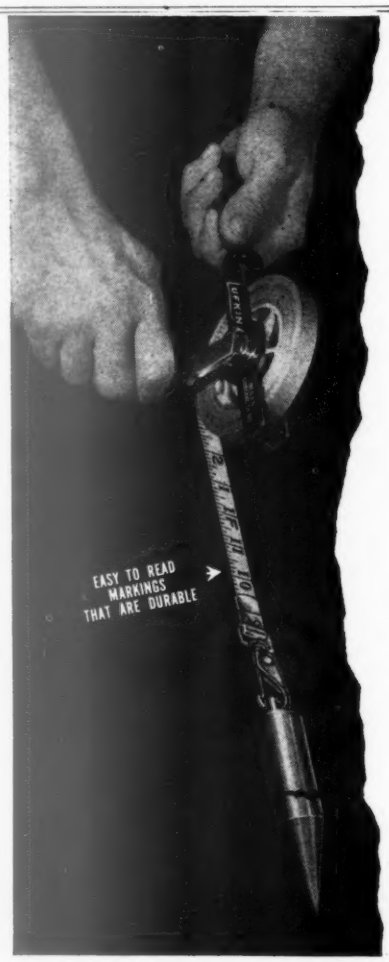
## Adds to staff

R. G. LeTourneau, Inc., Peoria, Illinois, and Stockton, California, manufacturer of heavy earthmoving and lifting machinery, announces the addition of Robert F. Nelson to its executive staff as vice president and assistant to the president.

Robert F. Nelson

Continually increasing activities of the company have brought Nelson into the new post to assume many of the business responsibilities of R. G. LeTourneau, giving the latter more time for development and engineering research. The new appointee will also work closely with Denn M. Burgess, executive vice president, and Merle R. Yontz, vice president and treasurer. One of his first assignments will be a trip to England this fall to assist in the establishment of a LeTourneau factory there.

Nelson for many years was a director and vice president of the Arma Corporation, Brooklyn, New York.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LUFKIN FOR ACCURACY

## Opens New York office

Continuing its expansion program, the Houdry Process Corporation, Wilmington, Delaware, has opened New York offices at 115 Broadway, New York City.

Robert B. Cragin

The new offices are headquarters for the commercial development division, project analysis division, and foreign sales department under the direction of Robert B. Cragin, vice president in charge of commercial development.

## Chemical department

Recognizing the increasing importance of manufacture of chemical products from petroleum, Standard Oil Company (Indiana) is organizing a chemical products department, it was announced by A. W. Peake, president.

The immediate duties of the department will be to explore the market for petroleum chemicals, work with research and manufacturing departments in developing and producing marketable derivatives, and manage sales and distribution.

The new department will operate under general direction of Bruce K. Brown, vice president in charge of development, with William B. Plummer as manager. Plummer was formely manager of Standard's development and patent department and during the war, until recently, a lieutenant colonel in the Air Technical Service Command, AAF. Howard R. Peterson, an experienced member of Standard's sales technical service will be in charge of sales development. Other staff members are being selected.

The use of new synthetic and catalytic processes for manufacturing petroleum products has reached a degree of importance overshadowing that of older methods of refining, Plummer pointed out in a statement in connection with the announcement. These processes are making new chemical by-products available and paving the way for still further developments in the petroleum chemical field.

Many common chemicals such as formaldehyde, methanol (wood alcohol, but not made from wood), and acetic acid can be made from petroleum sources, the Standard statement explains. The market for these and other less known petroleum chemicals is ordinarily among manufacturers of basic materials or consumer products rather than directly to consumers. For example, petroleum chemicals are used as softeners or plasticizers for rubber compounds and for many synthetic resins and plastics in coating materials and molded products, emulsifiers for various materials and uses, substitutes for linseed and other natural oils used in paints, components for potent new insecticides, and in making synthetic household and industrial washing compounds.

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## New officers CNGA

At the annual directors luncheon, held in the Los Angeles Athletic Club, M. L. Arnold, Richfield Oil Corporation, was inducted into office as president of California Natural Gasoline Association for the 1945-1946 term. At the same time, M. W. Kibre, General Petroleum Corporation of California, assumed the office of vice president of the association.

Arnold is a graduate of the University of Oklahoma where he received the degree of B.A. in chemistry in 1923. Migrating to California, he was employed by the Signal Hill Gasoline Company as a chemist. When this company merged, in 1927, with Richfield, Arnold continued with Richfield, advancing through the various jobs of plant operator, plant foreman, gas tester, chief chemist, to his present post of chief engineer of the gas

M. W. Kibre

M. L. Arnold

department. He was one of the original members of CNGA, his membership dating back to 1926. He has served on the association's technical committee and on its charcoal test committee. He has been a member of the CNGA board of directors since 1940, and, in 1944, he was vice president of the association. Arnold is a member of the American Chemical Society and Alpha Chi Sigma, professional chemical fraternity.

Kibre is assistant manager of the gas department, General Petroleum Corporation. After completing his studies in chemistry and engineering at the University of California, he spent a short time as a chemical engineer before becoming a laboratory man for General Petroleum at Santa Fe Springs, California. Later he was promoted to chemist and afterwards transferred to the company's Vernon plant as an engineer in the gas department of which he recently became assistant manager. He has been active in CNGA affairs, having served as chairman of the association's technical committee and its fall meeting committee, as well as a member of its charcoal test committee.

Directors elected for the 1945-1946 term include the following:

M. L. Arnold, Richfield Oil Corporation; A. H. Bell, Continental Oil Company; A. H. Bradford, West Coast Refining Company; J. A. Campbell, J. A. Campbell Company; I. V. Cassaday, Lomita Gasoline Company; F. J. Colton, Tide Water Associated Oil Company; F. E. Coyle, Tide Water Associated Oil Company; D. A. Cushman, Fullerton Oil Company; W. C. Dayhuff, California Research Corporation; F. F.


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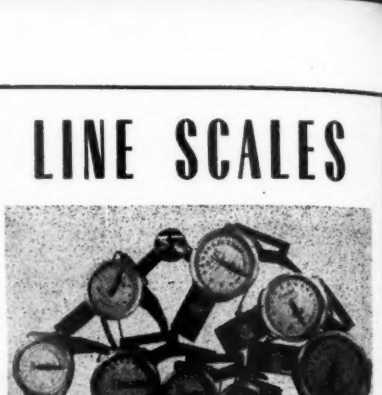

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The Taft chapter chairman is E. C. Spencer, The Norwalk Company.

The following have been appointed as committee chairmen:

Executive, M. L. Arnold, Richfield Oil Corporation; advisory, M. W. Kibre, General Petroleum Corporation of California; finance and budget, R. W. Heath, Signal Oil and Gas Company; entertainment, E. A. Brock, Southwest Welding and Manufacturing Company; membership, Coles Bason, Ingersoll-Rand Company; fall meeting. W. L. Rifenberick, Industrial Engineers, Inc.; program, M. L. Arnold; publicity, Harry Ransford, Signal Oil and Gas Company; gas report, William Moeller, Jr., Southern California Gas Company, and technical, C. L. Hutchings, Tide Water Associated Oil Company.

George L. Tyler is secretary of the association.

## W. E. Pratt Retires

The retirement of Wallace E. Pratt, director and member of the executive committee of Standard Oil Company (New Jersey), is announced by Ralph W. Gallagher, chairman of the board.

One of the world's outstanding geologists, Pratt rose in the practice of his profession to attain one of the most important management positions in the oil industry. He was elected director of Jersey Standard in 1937 and vice president in 1942, a position that he relinquished last fall.

Announcing his colleague's retirement, Gallagher said, "Wallace Pratt's contributions in the field of pure and applied geological science have been a major force in placing petroleum exploration on the scientific basis on which it operates today. His achievement has been of inestimable benefit not only to our company, but to the nation, especially in its time of urgent need, in a war against forces of aggression."

Under Pratt's direction, Jersey Standard has made pioneering studies of potential petroleum producing areas throughout the world. His book, "Oil in the Earth," is one of the most widely read and authoritative volumes on that subject.


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## Link-Belt promotions

Edward J. Burnell, vice president, Link-Belt Company, Chicago, Illinois, announces the appointment of A. C. Fellinger to the position of sales manager, power transmission machinery, with headquarters at the company's Ewart plant in Indianapolis, Indiana. This change is made to fill the vacancy caused by the untimely death of C. Walter Spalding.

Fellinger has had a wide experience in the field of power transmission, having joined the Link-Belt organization at Indianapolis in 1916. His last position was manager of sales through distributors, with headquarters in Chicago.

The sale and application of Link-Belt silent chain drives will hereafter be headed up by H. F. R. Weber, divisional sales manager, silent chain drives, with headquarters at the Ewart plant in Indianapolis. Weber started his Link-Belt career at the company's Philadelphia plant in 1915 as a power transmission engineer, and last held the position of central division manager for power transmission machinery, with headquarters in Chicago.

W. H. Woody continues as sales manager of the ball and roller bearing division, with headquarters at the company's ball and roller bearing plant in Indianapolis.

Sales through Link-Belt distributors will be supervised by F. A. Hurd, divisional sales manager, industrial distributor sales, Chicago; G. H. Unruh, divisional sales manager, industrial distributor sales, Philadelphia, and Harry Reisser, divisional sales manager, automotive equipment sales, Indianapolis.

## Waukesha promotes

In carrying out an expanded service program developed by Ortman Pederson, service manager of Waukesha Motor Company, Herman J. Loebl has been appointed manager of distributors' service-sales, a new department, and Harvey R. Wilson is advanced to the post of assistant service manager.

During his 17 years with the Waukesha Motor Company, Loebl has been in direct charge of field and factory branch service as executive assistant to the service manager. He has also acted as passenger traffic manager.

Prior to becoming associated with Waukesha Motor Company in 1928 he was assistant branch manager in Boston, and, later, general service manager of Sterling Motor Truck Company at its factory in Milwaukee.

Waukesha's new department, now headed by Loebl, will provide closer customer cooperation through field service so that factory facilities, methods, and standards may be brought within quick, easy reach of all owners and operators of Waukesha-power equipment, it is announced.

Wilson has been a part of Waukesha's service organization since 1927. Advancing from service stock room through stock control, cost and pricing, he was manager of service at the Waukesha Motor San Francisco branch from 1932-1936, returning to the factory at Waukesha to supervise field service engineers, he later became assistant to Loebl.

With the sudden and rapid expansion of the armed forces spare parts business, he was put in complete charge of this special phase of service activities in 1943.

Now called from this post to be executive assistant to Service Manager Pederson, as assistant manager of service he will have direct supervision of all operational functions of the service department relating to any customer requirement of whatever nature.

## Miss Crandal honored

Miss Emma E. Crandal, a scholar and chemist, who is known by her works wherever petroleum is refined or studied throughout the world, was honored by her associates of Universal Oil Products Company, including President D. W. Harris, at a testimonial dinner in the Spinning Wheel, Hinsdale, Illinois, July 13.

Miss Crandal is retiring after 20 years as head of the Universal library, over which she has presided since it was established in 1925.

Dr. Gustav Egloff was chairman of the dinner meeting. Speakers included Joseph G. Alther, former vice-president of Universal. Prof. V. N. Ipatieff, and R. B.


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Day, manager of the Riverside laboratories.

Miss Crandal is best known as the compiler and editor of a weekly bulletin of abstracts, which enjoys world-wide distribution and esteem among scientists and technologists in the petroleum and allied fields. Miss Crandal's service to the petroleum and chemical industries has extended beyond her work at Universal, however. For many years she has been a regular contributor to *Chemical Abstracts*, a semi-monthly publication of the American Chemical Society. She is also a member of the Special Libraries Association.

In addition to her editorial work and supervision of the library, Miss Crandal has conducted the literature searches, upon which much of the activities of the Universal research organization are based.

## Heads Ransome

Hobart C. Ramsey, executive vice president of Worthington Pump and Machinery Corporation, has in addition, been named president of the Ransome Machinery Company, subsidiary of Worthington in Dunellen, New Jersey.

Also named vice president and general manager of the Dunellen plant is J. G. Ten Eyck, who has just completed 5 years' active service with the U. S. Navy and who was formerly president of the industrial engineering firm of Ten Eyck, Inc. Kenneth W. Horsman, formerly superintendent of welding and steel fabrication at the Worthington Harrison works has been transferred to Ransome as works manager.

Newly elected directors of the Ransome Company are Ten Eyck and Carl F. Oechsle, vice president in charge of sales.

## Branch manager

The Wm. Powell Company, valve specialists and manufacturers of Cincinnati, Ohio, announces the appointment of Allen B. Stiles as manager of the Philadelphia and Baltimore territory. Stiles, whose office is at 1520 Locust Street, Philadelphia 2, Pennsylvania, is well known throughout the eastern section of the country, having represented the Crane Company for the last several years. In his new capacity, he will acquaint both the jobbing trade and industry generally with the complete line of Powell bronze, iron, steel, and corrosion-resistant valves.

## Nagel joins Fluor

R. E. (Bob) Nagel, formerly with the Universal Oil Products Company of Chicago, has accepted a position with The Fluor Corporation, Ltd., of Los Angeles and will make his headquarters at Fluor's New York offices as district sales manager. Nagel has been with Universal Oil Products Company for the last 24 years during which time he served in various capacities; first as a draftsman, then followed assignments as supervising construction engineer, superintendent of construction and operator on experimental and commercial thermal cracking units, and in the research and development department. For the last 12 years he has been in constant contact with various oil companies in the commercial development of refining processes and their problems. Nagel will continue in the latter service for The Fluor Corporation, Ltd.

## Valve lubricant

Merco Nordstrom Valve Company is now the exclusive distributor of a new valve lubricant that possesses unusual properties advantageous for a number of severe services.

This lubricant is a Dow Corning silicone product and is identified as Nordcoseal Lubricant No. DC234-S.

The lubricant is colorless and one of its outstanding properties is that its viscosity changes only slightly over a very wide temperature range. It is recommended for working temperatures ranging from minus 40°F. to plus 400°F. Due to its extremely low vapor pressure, it does not evaporate appreciably even at elevated temperatures.

Its principal services are steam, hot water, hot air, oxygen, high vacuum, also for dilute solutions of mineral acids (except nitric and hydrofluoric acid below 250°F.); hydrochloric acid, natural and synthetic rubbers, acetic acid, acetic anhydride, and ethyl alcohol below 250°F.

It is available only in soft bulk form for application by grease guns.

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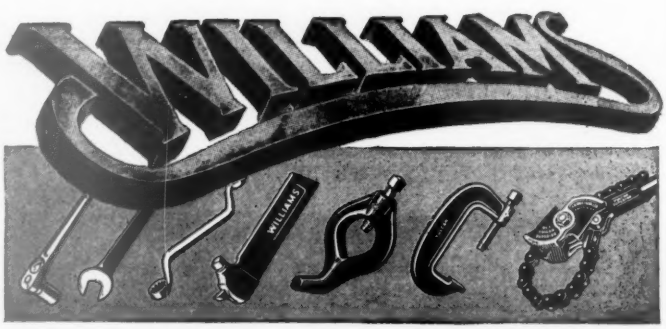



# Book Reviews

● **The Chemistry of Acetylene,** *by Julius R. Nieuwland and Richard R. Vogt. Rhinhold Publishing Corporation, 33 West Forty-Second St., New York, New York. Pages, 219. Price, $4.00.*

A brief and fairly complete account of the preparation, properties, and reactions of acetylene, together with an extensive classified biography is included in this book. The arrangement of the work is based entirely on a classification of the methods of preparation and type reactions of acetylene, rather than on considerations of historical sequence or industrial status. Divided into five chapters, the book takes up the following subjects in order: The physical properties, preparation, and purification of acetylene; metallo-derivatives of acetylene; the substitution of non-metal atoms or radicals for the hydrogen of acetylene; the addition of non-metallic elements and compounds to actylene, and the poylmerization of acetylene and condensation with carbon compounds.

● **Job Safety Training Manual,** *by Kenneth L. Faist and Stanton M. Newkirk. The National Foremen's Institute, Inc., Deep River, Connecticut. Pages, 52. Price, $5.00.*

Arranged in pamphlet-form loose-leaf notebook style, this new publication on safety is designed and written in the belief that those interested in industrial safety need more than generalities and mass propaganda usually employed in this field. It is really a brief and intensive training program for supervisors and is arranged so that it may be given in lecture form in five two-hour sessions. Included are three supplementary pamphlets: Carelessness Cripples, Safety for You, and Opportunities for Promotion Through Job Safety Training.

● **Review of Petroleum Geology in 1944,** *Quarterly of the Colorado School of Mines, by F. M. Van Tuyl, W. S. Levings and others. Golden, Colorado. Pages, 136. Price, $1.00.*

This April, 1945, issue of the *Quarterly*, volume 40, number 2, contains the third annual review of petroleum geology in 1944. It consists of 136 pages, the last 35 being devoted to a comprehensive bibliography. The subject matter includes important news items and constructive development in basic geology and in petroleum geology and borderline fields, as revealed by a search of the literature and the canvass of several leading workers in the petroleum industry. The most important contributions to the literature of the subject are included. Other publications of more local interest are listed in the bibliography. The review was compiled under the sponsorship of the AAPG.

● **Metals and Alloys Dictionary,** *by M. Merlub-Sobel. The Chemical Publishing Company, 234 King St., Brooklyn 31, New York. Pages, 238. Price, $4.50.*

This up-to-date reference work contains definitions of metallurgical terms, composition, properties, and uses of the important commercial alloys. It gives the physical constants and properties of chemical elements, description of machinery and processes used in modern metallurgy, and other pertinent information. It is designed for the use of all those who want to know about the applications and peculiarities of metals, alloys, and raw materials in metallurgy.

## AGA to meet

The twenty-seventh annual meeting of the American Gas Association will be held on October 24, 1945, at the auditorium of the Engineering Societies Building, 29 West 39th Street, New York.

To impose a minimum burden on transportation facilities, which are needed for the armed forces, and to obviate need for hotel accommodations, the association again will limit its yearly convention to a one-day meeting.

Officers will be elected at the general membership meeting in the morning and committee chairmen will read reports covering the activities of their sections during the last fiscal year. The luncheon meeting and the remainder of the day will be devoted to organizational work by departments and committees.

## New *Petroleum Engineer* staff member

Richard Sneddon, for the past two years editor of the *Petroleum World*, has joined the staff of *The Petroleum Engineer* as Pacific Coast editor, effective August 1, it has been announced by K. C. Sclater, editor. He succeeds Wallace A. Sawdon, who recently became editor of *Petroleo*.

Richard Sneddon

Sneddon began his industrial career as a research chemist with the Canadian Government and was later a chemist for the Canadian Pacific Railway. He was elected a Fellow of the Canadian Institute of Chemists. In 1923 he joined Union Oil Company of California and after 5 years of research work in diverse phases of petroleum, was placed in charge of pipe line and field gaging and testing laboratories covering all oil fields in California. He has written extensively for petroleum and general magazines. He was editor of the *Union Oil Bulletin* and other company publications and later held the post of manager of public relations in charge of all publications and publicity.

The new Pacific Coast editor has been publicity chairman of the American Petroleum Institute, Division of Production, Pacific Coast District, of the California Natural Gasoline Association, the American Association of Petroleum Geologists, and the American Society of Mechanical Engineers. He is secretary of the Petroleum Production Pioneers and a member of the National Association of Public Relations Counsel, Inc.

In his new duties, Sneddon will cover oil industry operations on the Pacific Coast and will also report the developments in foreign oil operations emanating from there.

## Southern Engine opens warehouse

Southern Engine and Pump Company announces the opening of a warehouse at 1306 Marilla Street, Dallas, Texas. Factory shipments permitting, stocks of engines, pumps, and parts will be carried for the convenience of customers, it is announced.

## Heads France Packing

France Packing Company, Philadelphia, Pennsylvania, manufacturer of metallic packing, announces a change of management. E. A. France, son of Adam Warren France, who patented France metallic packing and founded the business nearly 50 years ago, is now president and general manager. J. C. Allen is the new treasurer. Both France and Allen have been active in the manufacture of metallic packing for many years.

## Second "E" Award

American Meter Company's Philadelphia plants were notified recently that they had won a second war production award, entitling them to display the white star on their Army-Navy "E" flag.

## Junior Engineers elect

At its annual business meeting, the Junior Chemical Engineers of New York, 330 West 42nd Street, New York City, elected the following new officers for the coming year. President for the 1945-46 period will be William B. Hudson of the Foster-Wheeler Corporation, with Maurice R. Lyons of M. W. Kellogg Company as vice president. Richard Rosencranz, Shell Oil Company, Inc., has been elected secretary-treasurer and Andrew A. Melnychuk of Celanese Corporation will serve as assistant secretary-treasurer.

In addition to choosing regular officers at its final meeting of the year, the society elected Zola G. Deutsch, chemical engineering consultant, to honorary membership, a status already held by Walter J. Murphy, Stephen L. Tyler, and Sidney D. Kirkpatrick, all of whom, among "senior" engineers, have taken particular interest in the progress of the junior group.

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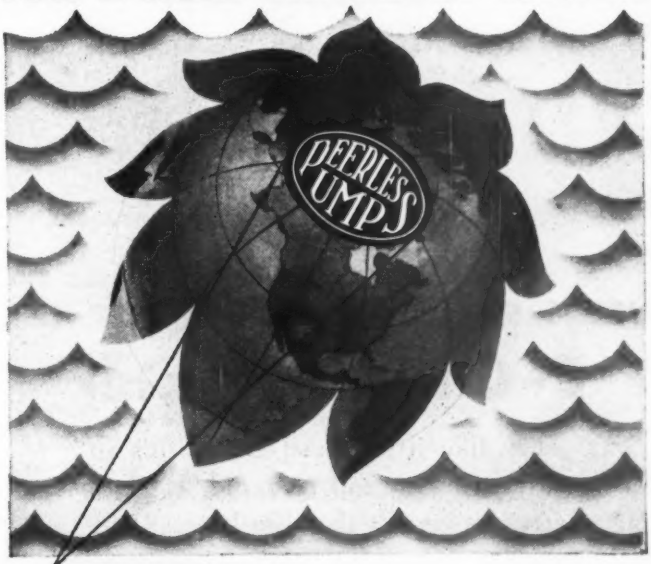


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## International division

The formation of a new division, Bendix International, to handle the comprehensive foreign trade program of Bendix Aviation Corporation, is disclosed by Ernest R. Breech, president.

Bendix International, he stated, will be under the direction of Charles T. Zaoral, general manager, who joined the corporation in January as coordinator of foreign affairs, after many years' experience in the foreign field for General Motors Corporation and Dodge Brothers, Inc.

The new division will handle throughout the world, with the exception of the United States and Canada, the products of the 17 divisions of the corporation. It has established headquarters at the corporation's New York office, 30 Rockefeller Plaza, New York City, and will maintain a staff of engineering, sales and service personnel that will be expanded here and abroad as world conditions permit.

Breech said that Bendix International had been established "to develop as fully as possible the opportunities for two-way international trade presented by the engineering, manufacturing, and distributing resources of our seventeen divisions."

The broad policies that have been established for Bendix International were explained by Zaoral, who emphasized that the company's activities would be developed abroad through three main channels, as determined by the situations in the various foreign countries. They will be, he said, export sale of products that the company manufactures here; manufacture by Bendix of its products abroad, and licensing of foreign manufacturers to produce under Bendix patents abroad.

Other appointments to the new division, in addition to Zaoral, include: F. A. Stanton, foreign patent counsel, who represented Bendix in Paris for many years and who will make his headquarters in New York; L. B. Coates, division comptroller, formerly of the central staff; Paul Moss, sales manager, and Harold McEnness, assistant sales manager. Fernando Jose Cardenas, formerly with Westinghouse, General Electric, and Sylvania, is manager of central and South American territories.

## Handles new line

Southern Engine and Pump Company, Houston, Texas, has made arrangements to handle products manufactured by the American Liquid Gas Corporation, Los Angeles, California. The products, which are marketed under the trademark Algas, consist of mixers or carburetors, converters, heat exchangers, and regulators.

Stocks of these units, as well as replacement parts, will be carried in Kilgore and Dallas, Texas. Southern Engine and Pump Company has engineers experienced in this line stationed at Houston, Dallas, San Antonio, Kilgore, and Alice, Texas, and New Iberia, Louisiana.

## New coating plant

Hill-Hubbell and Company Division of General Paint Corporation, Cleveland, Ohio, announces the opening on August 1 of a central steel pipe coating and wrapping plant at Girard, Ohio. The plant, which has a floor space of 60,000 sq. ft. under one roof, is equipped to coat and wrap pipe to all standard specifications, from ¾ in. nominal to 26 in. O. D. Machinery is permanently installed and is of the heavy, rugged, precision type of late design. All equipment is thermostatically controlled. Adequate switching arrangements and ample yard storage facilities have been provided.

## Unharmed in bomber crash

The crash of the fog-blinded B-25 Army bomber into the 79th floor of the Empire State Building on Saturday, July 28, did not result in injury to personnel, nor damage to the offices, of Creole Petroleum Corporation on the 67th floor, or the Chemical Construction Corporation on the 71st floor. The offices of the last named concern are directly below the spot where the bomber crashed into the building. Some personnel of both firms were in the building at the time of the accident. The offices of the 2 corporations were open for business as usual on Monday morning, July 30.

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The complete, widely used National Airoil line includes burners fabricated of a diversity of metals to withstand the actions of *every* liquid fuel, using all types of atomization at different temperatures; built in various rated capacities and designed for all pressures.

No matter what your service indicates—we have the correct burner.

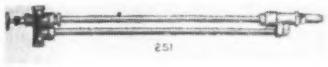

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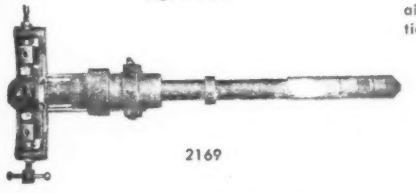
Fig. P-635A

**BURNERS . . .** for all commercial grades of fuel oil using all types of atomization; to operate with either high, low or gravity oil pressure; for high capacity up to 750 gallons per burner per hour—using steam, air or pressure atomization.



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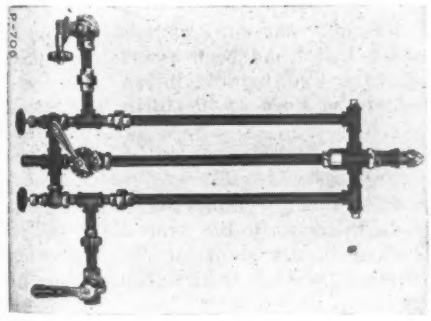
**BURNERS . . .** of all bronze—for acid oils or acid sludges; of all steel—for petroleum pitches and coal tars at temperatures up to 800° F.

With nearly 35 years' experience in the design and manufacture of fuel oil and gas burner equipment, we have a solution to your combustion problems.

To burn the very cheapest and lowest grades of heavy fuel oil or tar, requiring lower oil pressure and lower oil temperature, use the Type SA—Steam or compressed air atomizing type.



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To burn tar or pitch, use the high pressure steam or air atomizing Type SAR.

To generate steam at large capacity, etc., use the Type SAL.

To burn acids or caustic oil; sludges, asphalts, tank bottoms, Polymer oils, heavy petrolatum, organic oil residuum, waste cutting oils, sulphite pulp liquors, etc., use the Type SAD. It eliminates noxious fumes and stack solids; steam or compressed air atomizing.

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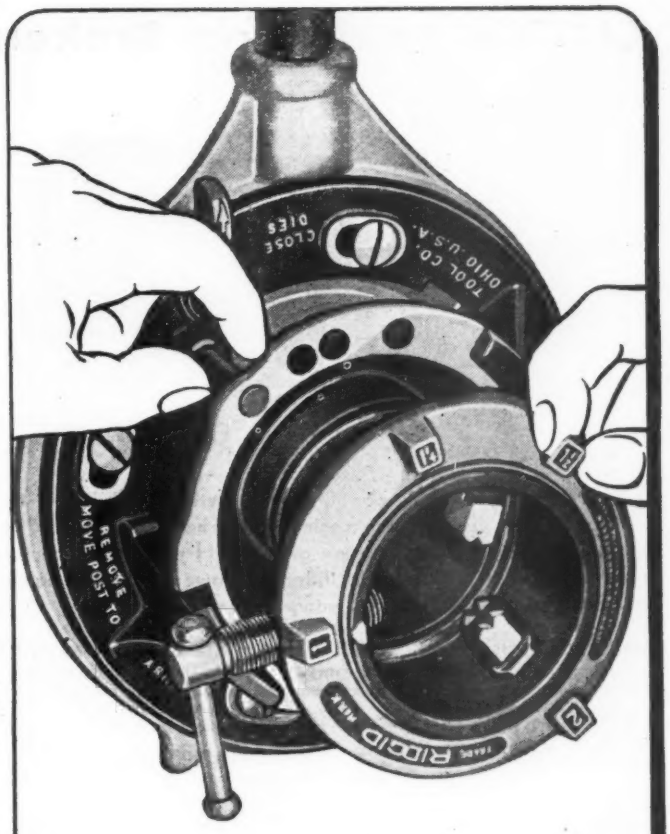


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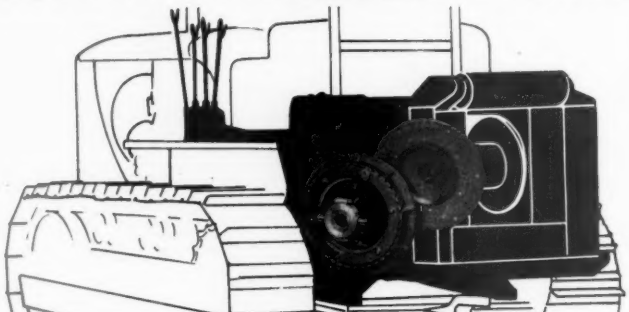

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### Engineering program

Plans for the establishment of an engineering research department and for expansion and reorganization of present engineering activities is announced by Standard Oil Company (Indiana). The new program was disclosed by Dr. M. G. Paulus, vice president, who stated that George W. Watts has been named director of engineering of the manufacturing department and D. A. Monro, chief designing engineer of the department. Under the new plans Watts will be in charge of all engineering work in the manufacturing department but will devote his time principally to the activities of the engineering research department. All other engineering activities will be under the direct charge of Monro.

P. L. Krauel has been appointed chief engineer of the engineering division, Whiting Refinery, where the company's largest engineering unit is situated. Krauel will serve as the administrative head of the division, which has been enlarged to include six departments, each to be headed by an assistant chief engineer.

The oil design department will be supervised by W. G. Guild, acting assistant chief engineer. A. T. Milbrook, assistant chief engineer, will supervise the utility design department. W. K. Brown has been appointed acting assistant chief engineer in charge of the newly-created plant engineering department. This department will handle engineering matters pertaining to construction, inspection, and field engineering, and will provide consulting services to the operating and design departments. C. E. Dyckman is made assistant chief engineer, estimating department, and will continue to direct and supervise the work of the estimating engineers. W. R. Burrows will be in charge of the newly created engineering development department, with the title of assistant chief engineer. D. F. Purdy, assistant chief engineer, will continue to supervise the drafting department.

### Temmel promoted

Andrew C. Temmel, formerly field service engineer, has been appointed manager of engineering sales service of the National Tube Company, subsidiary of United States Steel Corporation. He will make his headquarters in Pittsburgh, Pennsylvania.

### Cross dies

W. L. Cross, chief clerk of Spang and Company, died on August 6, at the age of 64. Cross had been associated with the Butler, Pennsylvania, cable-tool manufacturing firm for 31 years. He was buried at the town of his birth, Clintonville, Pennsylvania.

### Third star

Robert P. Patterson, Under Secretary of War, has announced the award of the third star to the Army-Navy "E" pennant, given to the Chicago district plants of The Youngstown Sheet and Tube Company, for high achievement in the production of war materiel.

The general offices and main plants of the company are at Youngstown, Ohio.


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## Sidwell to Tulsa University

C. V. Sidwell, widely known petroleum engineer, has been named head of the production department of the University of Tulsa college of petroleum sciences and engineering, Dr. C. I. Pontius, university president, announced.

After more than 20 years of important activity in the oil industry from Mexico to Montana, Sidwell joins the Tulsa faculty to direct work in a department that university officials are reorganizing and expanding with an eye to postwar enrollment increases.

"Sidwell will join us in reorganizing our production work to give proper attention to development, exploitation, drilling, transportation, and the new field of reservoir studies," Dean R. L. Langeneim, university engineering head, explained. "We expect this revised program also to lay the foundation for graduate work in production paralleling that already established in refining and geology."

The new Tulsa professor is the president of the Sidwell engineering and the drilling mud companies, which he organized after 20 years as an engineer and executive with major oil companies and in private practice.

After receiving his basic education and graduate work in geology at the University of Oklahoma, where he also taught freshman classes, Sidwell joined the Cortez Oil Corporation (Atlantic Refining) for work at Tampico, Mexico, as a subsurface geologist.

A year later he went with Pan American Petroleum and Transport (Doheny and Standard of Indiana).

Subsequently, after 7 years with Amerada Petroleum Corporation as division production engineer in Oklahoma and Kansas, Sidwell was engaged by the British American Oil Producing Company as general superintendent of drilling and production.

In 1937 Sidwell entered into personal drilling and development operations and acted as consulting engineer. The latter activity led to a two-year assignment for the Oklahoma City Wilcox Secondary Recovery Association composed of 38 companies. The work involved research into the possibility of applying secondary recovery to the Oklahoma City Wilcox zone.

For the last 4 years, in addition to other activities, Sidwell has been consulting engineer for various companies and individuals, including the War Department and Northern Ordnance, Inc.

## Forms export company

Increased activity in export markets is anticipated by the Chiksan Company, Brea, California, with the announcement of the establishment of an affiliate company to handle export sales. The new company, Chiksan Export Company, will headquarter in Brea, with branch offices in New York and Houston.

W. Edgar Spear, president of the Chiksan Company, heads the new export company, with Lee J. Laird, Chiksan vice president and sales manager, in charge of export sales. The New York office at 50 Church Street, will be managed by H. A. Maland, and the Houston office, now in process of organization, with temporary mailing address P. O. Box 276, Houston 1, Texas, will be under the management of G. R. Winder who transfers to Houston from the Chiksan home office in Brea.


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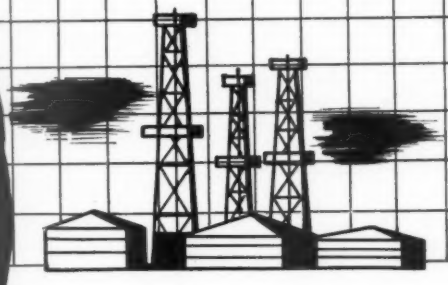
## When Tret-o-lite goes in...

## Treating Costs

# Go Down



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